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CREEL CENSUS STUDY ON FOX, MARSH, AND TAGISH LAKES IN THE YUKON TERRITORY, 1983.

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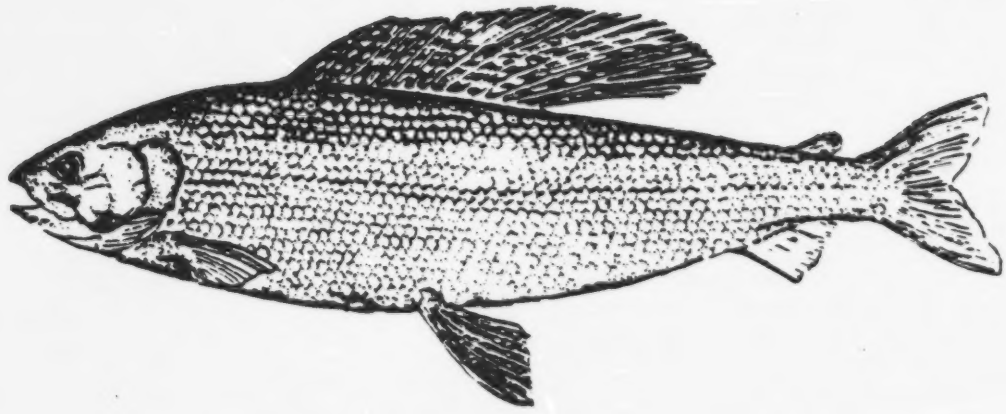

YUKON RIVER BASIN STUDY

This project was completed for the Yukon River Basin Study, an intergovernmental study funded by the governments of Canada, Yukon and British Columbia.

Fisheries and Oceans Pêches et Océans

Canada

CREEL CENSUS STUDY

ON FOX, MARSH, AND TAGISH LAKES

IN THE YUKON TERRITORY

1983

by

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and
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June 1984

Department of Fisheries and Oceans
Whitehorse, Yukon

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This report was funded by the Yukon River Basin Committee under the terms of "An Agreement Respecting Studies and Planning of Water Resources in the Yukon River Basin" between Canada, British Columbia and Yukon. The views, conclusions and recommendations are those of the authors and not necessarily those of the Yukon River Basin Committee, or the Governments of Canada, British Columbia or Yukon.

This Project Report was completed for Yukon River Basin Study Project 61.

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ABSTRACT

Creel census and sampling programs were conducted in 1983 at Fox, Marsh and Tagish lakes in the Yukon Territory. The data collected included angler catch, effort, success rate and place of residence, as well as the composition of the catch in terms of species, size, age and sex.

INTRODUCTION

Currently, the fisheries resources of the Yukon River basin are exploited by four user groups: native, sport, domestic (non-native subsistence) and commercial fishermen. The most active and by far most extensive of these groups consists of resident and non-resident sport fishermen/anglers. The maintenance of the present fish stocks is therefore a vital component to the lifestyle and economy of residents and tourists alike. From 1960 to 1980, Yukon angling licences increased almost threefold with the most dramatic increase occurring during the 1970 to 1980 period (Fig.1). In the 1970 to 1971 season, a total of 8,504 licences were sold, whereas this number had climbed to a peak of 17,351 in the 1981 to 1982 season (Appendix 1).

In spite of the substantial increase in angling interest in the recent decade, Paish (1981) surprisingly noted a decreasing trend in the overall catches as determined from questionnaire-type surveys conducted in 1971, 1975 and 1980. Specifically, it was pointed out that the total non-salmon catch declined from 231,000 fish in the early 1970's to 186,300 in 1975. Preliminary data from the 1980 Yukon Territory component of the National Sport Fishing Survey disclosed a continued decline in retained catch to 156,200; yet an additional 136,500 fish were reportedly released (Horler et al. 1983).

The suggestion of decreasing Yukon fish stocks, as noted in the above catch statistics, combined with increasing fishing effort prompted the Department of Fisheries and Oceans (DFO) to embark on a three-step management program commencing in 1981. The components of this program were as follows:

1. to determine the levels of allowable harvest of fish from specific Yukon lakes based on a productivity index;

2. to partition the estimates of fish yields according to lake-specific species composition data; and

3. to determine current levels of harvest on a lake-specific basis.

The first component was investigated in 1981 through the application of the Morphoedaphic Index (MEI) to 67 lakes located throughout the Yukon (Horler, in prep'n). In order to partition some of the lake-specific fish yield estimates compiled from the 1981 study, species composition and baseline biological data were collected in 1982 and 1983 from 18 lakes, as part of the Yukon River Basin Study (Horler et al.1983).

Although it was recognized that the initial two components of the three-step program were far from complete, there was a growing need to commence the examination of methods aimed at fulfilling the final step, that is, the determination of catch levels for specific lakes so that actual harvests could be compared to previously determined guideline harvest levels.

From May to September 1983, creel census and sampling programs were conducted at Fox, Marsh and Tagish lakes in the Yukon Territory. These lakes were selected in recognition of their recreational importance to both resident and non-resident fishermen. In addition, they were known to contain significant populations of lake trout and Arctic grayling, the two most highly prized species in the non-anadromous sport fishery.

Fig. 1. Historical Yukon angling licence sales, 1983.

The objectives of the 1983 study were to obtain angler catch, effort, success rate and place of residence data; determine the composition of the catch in terms of species, size, age and sex; and where possible, compare the actual harvests with guideline yields previously calculated from the Morphoedaphic Index.

Funding for this study was provided through the Yukon River Basin Study, the Department of Fisheries and Oceans, the Yukon Territorial Government through a Community Recovery Job Creation Program and a Federal Summer Canada Student Program administered by the Yukon Conservation Society.

STUDY AREA

The three lakes surveyed during the study, Fox, Marsh and Tagish are located within the Lake Laberge ecoregion of the Yukon (Fig.2) (Oswald and Senyk 1977). Morphological characteristics for the three lakes are presented in Table 1.

FOX LAKE

Fox lake is a long, narrow lake covering an area of 1,660 ha and surrounded by the low rolling hills of the Miner's Range. The lake drains south via Richthofen Creek into Lake Laberge and subsequently into the Yukon River (Fig.2). The region is underlain by sedimentary rock with surficial deposits of morainal and glaciofluvial materials (Oswald and Senyk 1977). Local vegetation is composed of white and black spruce interspersed with lodgepole pine. Mosses and low shrubs dominate the understory. The average annual temperature is -5°C with an average annual precipitation of 247 mm (Canada Dept. Env. 1982).

The lake is located 47 km north of Whitehorse and is easily approached along the Klondike Highway (Fig.2). Two public boat launches, one at the south end of the lake and one in the Territorial campsite (Fig.2), provide convenient access for recreational boaters. The campground consists of 38 sites and offers limited facilities for both overnight and day use. Lake residences include five dwellings which are occupied on a year-round basis and a further six units which were developed primarily for weekend and seasonal use.

Since the opening of the Klondike Highway in the early 1950's, Fox Lake has been apparently subject to moderate to heavy sport fishing pressure. According to local knowledge, angler activity in recent years has declined on the lake and fishing is often a secondary pursuit for tourists and residents participating in other recreational activities. Local residents and cabin owners are known to ice-fish but this activity is minimal and the harvest is low.

Fox lake was designated for commercial fishing of lake trout and whitefish from 1961 until 1964 when it was closed due to poor fish quality. Although native food fishing is permitted, no other net licences have been issued since that time.

MARSH LAKE

Marsh lake is one of a series of large lakes recognized as headwaters of the Yukon River system (Fig.2). The lake is surrounded by low rolling hills with some peaks rising to elevations of 1000 m or more. This large, eutrophic lake covers an area of 9,630 ha. Fed by the Tagish River and other small rivers

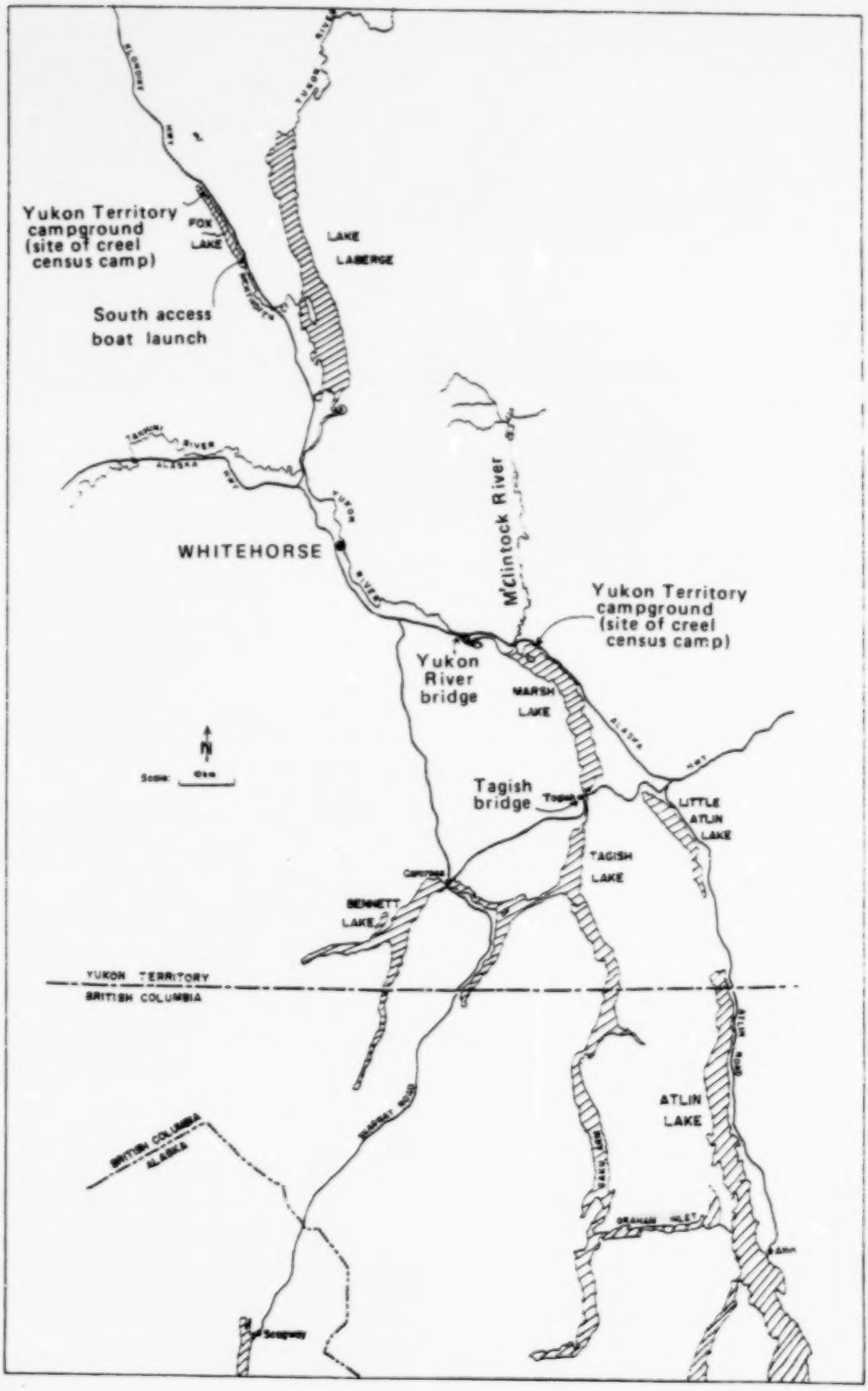

Fig. 2. Location of Fox, Marsh and Tagish lakes.

Table 1. Summary of morphological characteristics for Fox, Marsh and Tagish lakes.[a]

PARAMETER	FOX LAKE	MARSH LAKE	TAGISH LAKE
Area (ha)	1,660	9,630	35,400
Elevation (m)	765	653	-
Volume ($m^3 \times 10^6$)	474	12,200	21,800
Length ($m \times 10^3$)	18.3	30.1	95.3
Mean Width ($m \times 10^3$)	0.9	3.2	3.7
Mean Depth (m)	28.6	12.8	61.5
Maximum Depth (m)	47.0	51.5	306.5
Shoreline ($m \times 10^3$)	38.8	83	463.8

[a] Data Sources: Fox Lake (Horler and Jarvis, in prep'n); Marsh and Tagish lakes (Pharo 1984, in prep'n).

and creeks, Marsh Lake has an annual turnover time of 0.17 years (Pharo 1984, in prep'n).

Fine textured sands appear often throughout the area and are especially concentrated along the north shore of the lake. Soils are composed mainly of proglacial materials with rock outcroppings common along the east shore. A marshy shoreline is found along much of the lake. White spruce and poplar are most common along the lake waterfront while lodgepole pine occurs frequently in burn areas and at higher elevations. The average annual temperature is -1.2°C with an average annual precipitation of 261 mm (Canada Dept. Env. 1982).

Marsh Lake is the most developed of any lake within the Yukon Territory. Cottage lot subdivisions have been established at Army Beach, Judas Creek, Constabulary Beach and at McClintock Bay, with many residences being occupied on a permanent basis. A Territorial campsite and day use area are located near Army Beach, 42 km from Whitehorse.

Access to Marsh Lake is possible from several points along the Alaska Highway. Boat launches are located at the Yukon and McClintock River bridges, the Lake View Resort Marina and at the former site of the Marsh Lake maintenance camp. A launch located at the Tagish River campground also provides access by way of the Tagish River.

The lake is a very popular year-round fishing area with Whitehorse residents and tourists. Erratic water fluctuations, extensive shallow beaches and dense vegetation all combine to minimize opportunity for casting from shore. Boats and fishing gear are available from the Lakeview Resort and Tagish Marina.

Fishing pressure on Marsh Lake is currently believed to be moderate to heavy. Historically, the lake has supported both extensive netting and sport fishing activity. The former is now restricted to a few native food fishing permits, while the latter has continued to expand.

TAGISH LAKE

Although Tagish Lake lies within the same ecoregion and shares many vegetative characteristics as Marsh Lake, it displays very few similar morphological features. This large, deep lake is fed by both Atlin and Bennett lakes and drains into Marsh Lake through the 10 km long Tagish River (Fig.2). Surrounded by high mountain peaks, the lake has a steep shoreline and a maximum recorded depth of 306.5 m (Pharo 1984, in prep'n).

Access to the lake can be gained at Carcross, through Nares Lake and at the bridge near the community of Tagish, 107 km from Whitehorse (via Carcross). Development in the vicinity of the Tagish bridge includes cottage lots and a Territorial campsite, with a marina providing services for boaters and shore fishermen.

Angling from the bridge is very popular with tourists and residents alike. Fishing success, especially with lake trout, is common throughout most of the year. Sport fishing pressure on the lake is currently considered to be moderate to high with the majority of the activity occurring in early summer.

Tagish Lake is known to have historically supported populations of large lake trout and for this reason is popular with fishermen seeking trophy fish.

METHODS

CREEL CENSUS

Interview procedure

All anglers, regardless of fishing success, were questioned on the number of fish caught and kept, the species targeted on, the hours fished and gear used. This information was recorded for each fish species. The total weight of the retained catch for each party was determined or in the case of unsampled fish, the weight was estimated by the census worker.

Anglers were asked their usual place of residence, i.e. Yukon, Canada, United States or other, and for comments, suggestions or general feelings about their fishing experiences in the Yukon. The recording form used during the study (Appendix 2) was derived from the one used in a previous creel census study (D'Estimauville 1981).

Fox Lake

The creel census of the Fox Lake area was conducted between May 22 and September 25, 1983. Prior to lake break-up creel workers interviewed anglers at Richthofen Creek (Fig.2) on three consecutive weekends beginning May 14, 1983. During the same period, this area was monitored to a lesser extent on week days.

The lake became free of ice by May 20 and a semi-permanent camp was established at that time at the Fox Lake Territorial campground. Any angler activity associated with this main access point could then be monitored on a 24-hour basis. The south access area was surveyed by creel workers travelling from the main camp by boat. All interviewing continued throughout the day with peak times usually occurring in the late evening. Cabin owners were interviewed several times during the season, either on the water or in residence.

Marsh and Tagish lakes

Creel census information from Marsh and Tagish lakes was first obtained at the Kiwanis Fishing Derby held on June 18 and 19, 1983. Continous day-to--day interviewing was conducted from July 17 to September 26. During this time, the census crew worked either by road or water from a semi-permanent camp establishment at Army Beach.

Two different approaches were used to assess fishing activity and success at Marsh and Tagish lakes. The first involved on-site interviews where anglers were interviewed either upon returning from a day's fishing or when actively fishing. These interviews were conducted as described in a previous section.

The second approach consisted of a door-to-door survey in the numerous subdivisions and recreational cottage areas, and encompassed both permanent and seasonal residents. The same basic interview procedure was followed as outlined above except that anglers in this case were asked for catch and effort information pertaining to the entire season.

Analysis of catch and effort

To assess levels of effort, information obtained from the creel census was analysed in terms of fish caught per hour. The interpretation of this result is dependent on a clear understanding of the procedures involved when compiling the data. Treatment of the data with respect to the analysis of effort is outlined below.

The estimated harvest of all species was calculated from the information compiled from the daily interviews of active fishermen as well as the residential interviews.

The catch per unit effort (C.P.U.E.) values were calculated using information obtained only during the on-site interviews of fishermen. Data compiled from the residential interviews, conducted some time after the actual fishing experience, were not used in this study because specifics regarding catch and effort often could not be recalled during residential interviews.

Differentiation between species caught and species fished for was also considered when generating C.P.U.E. values. Incidental catches were defined as the capture of one species as a result of angling for another. When such a situation arose, the effort for the caught species was considered to be zero. This effort was also incorporated into the calculation of the C.P.U.E for all species.

A further variable which had to be considered occurred when anglers were undecided as to which species they had been fishing. If the angler was successful, the catch related statistics would then be included in the effort calculations for the captured species. However, if no catch was obtained, effort figures were then limited to inclusion in the calculation of effort expended for all species only.

BIOLOGICAL INVESTIGATIONS

Size, age and condition

Following each interview, the creel workers sampled all or a portion of the catch for fish length, weight and age. All subsampling was random. Fork and standard lengths were recorded to the nearest millimetre. Fork length was defined as the distance from the tip of the snout to the fork in the caudal fin, while standard length was measured from the tip of the snout to the hypural notch. Weight was measured to the nearest 25 g using a 30 kg capacity suspended scale.

For aging the fish, five scales were removed from the preferred area of any grayling and whitefish and preserved on numbered gum cards. These scales were later pressed onto acetate and interpreted within the Department of Fisheries and Oceans laboratory in Whitehorse. Otoliths were removed from all lake trout and burbot and stored dry until their interpretation by DFO and contract personnel in Whitehorse. The use of otoliths for the aging of lake trout has proven to be a more precise method than the use of scales (Dubois and Lagueux 1968).

In order to assess growth rates, age-specific mean weights and fork lengths were determined for the relevant species in each lake. Due to the limited samples obtained, this analysis was carried out only for lake trout from all lakes and Arctic grayling from Fox Lake.

To test for any significant differences in the growth rates between lakes, a Distribution-Free Test (Friedman, Kendall and Babbington Smith) was performed for lake trout (Hollander and Wolf 1973). Following this, the Distribution-Free Multiple Comparison Based on Friedman Rank Sums was performed to establish which lakes differed significantly in their growth rates at a level of 0.05.

Condition (K), calculated as an indication of 'fatness' and 'well-being' (Bagenal 1978) was determined for each fish using the equation:

$$K = \frac{Wx10}{L}$$, where W = weight in grams and
L = fork length in millimeters

Sex composition and maturity

All fish were sexed where possible. When sex could not be determined, the fish were recorded as immature. Sexual maturity was classified according to the following indices of condition:

1 - immature - no gonad development, difficult to determine sex;
2 - maturing - gonads developing but spawning unlikely this season;
3 - mature - gonads filling 2/3 of the body cavity, fish will spawn this season;
4 - ripe - gonads filling the body cavity, loose sex products present, eggs completely round, testes white, fish in spawning condition;
5 - spent - gonads collapsed, fish spawned out.

Fish classified by index 1 were designated as "immature", by index 2 as "maturing" and by index 3, 4 and 5 as "mature". The percentage represented by each of these three catagories within an age class was used to illustrate the trends in maturation.

RESULTS AND DISCUSSION

CREEL CENSUS

Angler success levels

The daily numbers of interviews conducted, active anglers identified and percent success rate of catching at least one fish per day are shown in Table 2. A total of 475 interviews were conducted at Fox Lake where 786 active anglers were identified and an average daily success rate of 31% was recorded. At Marsh Lake, a total of 62 active anglers were identified from the 37 interviews conducted, and an average daily success rate of 55% was recorded. At Tagish Lake, 255 active anglers were identified from the 134 interviews conducted and an average daily success rate of 34% was observed.

The greatest number of interviews was conducted at Fox Lake due to the longer survey period on this smaller, more manageable system. The size of both Marsh and Tagish lakes limited the degree to which a comprehensive survey could be conducted. Variation in the levels of fishing success from one lake to another, besides possibly reflecting stock abundance, could be attributed to the opportunities of fishermen to reach desirable waters. For example, the high overall success rate in Marsh Lake reflects directly the opportunities afforded for grayling fishing.

Catch composition

During the 1983 study period, anglers at Marsh, Tagish and Fox lakes caught lake trout (Salvelinus namaycush), Arctic grayling (Thymallus arcticus) and northern pike (Esox lucius). The Fox Lake catch also included humpback whitefish (Coregonus clupeaformis) and burbot (Lota lota).

At Fox Lake, lake trout comprised 58% of the 171 retained fish, Arctic grayling comprised 30%, pike 5%, humpback whitefish 5% and burbot 2% (Table 3). The lake trout harvest amounted to 80.1 kg or 62% of the total weight for all species; grayling totalled 23.4 kg (18%), pike 10.2 kg (8%), humpback whitefish 12.0 kg (9%) and burbot 3.6 kg (3%) (Table 3).

At Marsh Lake, the reported retained sport catch from all sources totalled 320 fish; 61% were lake trout, 26% grayling and 13% pike (Table 4). These totals amounted to 339.5 kg (79%) lake trout, 35.8 kg (8%) grayling and 56.2 kg (13%) pike. Poor weather conditions combined with high winds and rough water kept boaters on shore throughout most of the study period. Given more favourable weather conditions, Marsh Lake catches would inevitably been higher, especially for lake trout.

At Tagish Lake, the retained sport catch totalled 490 fish; 94% were lake trout, 1% grayling and 5% pike (Table 5). These totals amounted to 908.3 kg (94%) lake trout, 2.7 kg (0.3%) grayling and 55.8kg (6%) pike.

Table 2. Summary of interviews, active anglers and daily success rates at Fox, Marsh and Tagish lakes, 1983.[a]

	FOX LAKE			MARSH LAKE			TAGISH LAKE		
Date	No. of Interviews	No. of Active Anglers	% Successful	No. of Interviews	No. of Active Anglers	% Successful	No. of Interviews	No. of Active Anglers	% Successful
May 22	8	12	83		Not surveyed			Not surveyed	
29	6	8	12		Not surveyed			Not surveyed	
Jun 05	22	54	24		Not surveyed			Not surveyed	
12	34	64	5		Not surveyed			Not surveyed	
19	23	34	35	Kiwanis Fishing Derby Not available[b]			Kiwanis Fishing Derby Not available		
26	21	42	34		Not surveyed			Not surveyed	
Jul 03	32	55	37		Not surveyed			Not surveyed	
10	13	28	29		Not surveyed			Not surveyed	
17	47	82	28		Not surveyed		22	42	60
24	68	105	29	3	3	67	9	18	39
31	51	73	10	6	7	86	26	40	5
Aug 07	23	35	20	3	4	50	13	26	38
14	21	36	-	3	10	40	20	46	43
21	38	50	24	1	1	-	3	6	33
28	23	32	22	4	12	67	9	14	43
Sep 04	28	29	24	6	7	71	18	28	50
11	7	8	65	3	9	22	11	29	31
18	10	19	70	7	9	44	3	6	-
25		Not surveyed		1	1	100		Not surveyed	
Total	475	786	31	37	62	55	134	255	34

[a] Angler considered successful if caught at least one fish that day.
[b] Kiwanis Fishing Derby unsuccessful anglers were not interviewed.

Table 3. Summary of angler catch, Fox Lake, 1983.

SPECIES	Fish Caught No. (%)	Fish Kept No. (%)	Estimated Total Weight Kept Kg. (%)	Average Weight/Fish Kept Kg.
Lake trout	101 (33.9)	99 (57.9)	80.1 (61.9)	0.8
Arctic grayling	158 (53.0)	52 (30.4)	23.4 (18.1)	0.5
Northern pike	28 (9.4)	9 (5.3)	10.2 (7.9)	1.1
Humpback whitefish	8 (2.7)	8 (4.7)	12.0 (9.3)	1.5
Burbot	3 (1.0)	3 (1.8)	3.6 (2.8)	1.2
All Species	298 (100)	171 (100)	129.3 (100)	N/A

Table 4. Summary of angler catch and information sources, Marsh Lake, 1983.

SPECIES	Source [a]	Fish Caught	Fish Kept No. (%)	Estimated Total Weight Kept Kg.	%	Average Weight/Fish Kept Kg.
Lake trout	Resident	-[b]	161	282.0		1.8
	On-site	2	2	5.5		2.7
	Derby	-[b]	32	52.0		1.6
	Total	N/A[c]	195 (60.9)	339.5	(78.7)	N/A
Arctic grayling	Resident	-[b]	51	23.2		0.5
	On-site	100	32	12.7		0.4
	Derby	-[b]	0	0		0
	Total	N/A	83 (25.9)	35.8	(8.3)	N/A
Northern pike	Resident	-[b]	10	7.5		0.8
	On-site	19	19	19.3		1.0
	Derby	-[b]	13	29.4		2.3
	Total	N/A	42 (13.1)	56.2	(13.0)	N/A
All Species			320 (100)	431.5	(100)	N/A

[a] Sources: "Resident"- cabin residents - Judas Creek, McClintock Bay, Constabulary Beach, Army Beach, Lewes River Bridge;
"On-site" - on-site interviews of active anglers;
"Derby" - Kiwanis Fishing Derby weigh-in station, Marsh Lake Marina.

[b] Not possible to determine.

[c] Not available.

Table 5. Summary of angler catch and information sources, Tagish Lake, 1983.

SPECIES	Source [a]	Fish Caught	Fish Kept No. (%)	Estimated Total Weight Kept Kg. (%)	Average Weight/Fish Kept Kg.
Lake trout	Resident	-[b]	208	437.8	2.1
	On -site	120	120	153.4	1.3
	Derby	-[b]	134	317.1	2.4
	Total	N/A[c]	462 (94.3)	908.3 (93.9)	N/A
Arctic grayling	Resident	-[b]	0	0	0
	On-site	2	2	1.9	1.0
	Derby	-[b]	2	0.8	0.4
	Total	N/A	4 (0.8)	2.7 (0.3)	N/A
Northern pike	Resident	-[b]	0	0	0
	On-site	6	2	4.2	2.1
	Derby	-[b]	22	51.6	2.3
	Total	N/A	24 (4.9)	55.8 (5.8)	N/A
All Species			490 (100)	966.8 (100)	N/A

[a] Sources: "Resident"- cabin residents - Tagish, Tagish River and Lake;
"On-site" - on-site interviews of active anglers;
"Derby" - Kiwanis Fishing Derby weigh-in station, Tagish Bridge.

[b] Not possible to determine.

[c] Not available.

In both Marsh and Tagish lakes, the total catch information was incomplete due to difficulties in covering succesfully all access points. Furthermore, it was usually possible to interview the numerous lake residents only once during the season and frequently they were unable to recall specific details especially regarding fish releases. It was therefore difficult to obtain an accurate account of the numbers of fish released, although the numbers of fish kept shown in Tables 4 and 5 are felt to be accurate.

By comparison, since all anglers interviewed at Fox Lake were active, it was possible to determine a relationship between kept and released fish. Of the 101 lake trout captured, 99 fish or 98% were retained, clearly indicating the desirability of this species (Table 3). Of the 158 grayling captured, 33% were retained in 1983, compared to the 85% retention level reported for 1981 (D'Estimauville 1981). Retention rates for other species were 32% for pike, 100% for humpback whitefish and 100% for burbot (Table 3).

Catch per unit effort (C.P.U.E.)

Due to the uncertainty associated with those residential interviews conducted some time after the actual fishing experience, C.P.U.E. values were derived from on-site interviews only. During the study period, anglers spent a total of 1,378.5 hours of active fishing at Fox Lake, 125.5 hours at Marsh Lake and 1,500 hours at Tagish Lake (Tables 6, 7 and 8 respectively). The value for Fox lake represents only 28% of the effort expended in 1981 when fishermen spent an estimated 5,000 hours angling (D'Estimauville 1981). However, the 1981 level was derived from extrapolated data and is probably less accurate compared to the 1983 findings. Nevertheless, the difference between the two years is probably still considerable and may be partly attributed to the poor weather conditions that prevailed during the 1983 study.

It was difficult to assess the differences in fishing activity among the lakes studied since the interview period varied from lake to lake. For example, 41.7% of the hours recorded at Tagish Lake were fished during the two-day period of the fishing derby (Table 8). The fishing derby was not monitored at Marsh Lake leaving a potentially high portion of the seasonal activity unrecorded.

The logistics of the Fox Lake survey allowed for a complete and accurate monitoring of angler activity. On the other hand, with the exception of the Kiwanis Fishing Derby weekend, June 18 and 19, surveys on Marsh and Tagish lakes were not begun until mid-July. Although considerable activity was reported at Tagish bridge throughout the season, angling on the open lakes is known to be drastically reduced in early July when the lake trout inhabit the cooler, deep water below the thermocline. Such angling behavior was confirmed repeatedly by local residents and businesses catering to sport fishing. Since the relationship between post-ice-breakup and mid-summer angling activity levels was not known precisely, it would have been dangerous to extrapolate the findings from the latter period. Also, the activity pattern at Fox Lake could not be used confidently as an indicator for the other two lakes

Table 6. Catch per unit effort by species, Fox Lake, 1983.

Week Ending	NUMBER OF HOURS FISHED					NUMBER OF FISH CAUGHT					CATCH PER UNIT EFFORT			
	Lake Trout	Arctic Grayling	Northern Pike	Other[a]	Total	Lake Trout	Arctic Grayling	Northern Pike	Other[b]	Total	Lake Trout	Arctic Grayling	Northern Pike	All Species
May 22	17.0	52.0	0	0	69.0	0	30	0	0	30	0	0.57	0	0.43
29	13.0	1.0	0	0	14.0	1	0	0	0	1	0.08	0	0	0.07
Jun 05	54.5	2.5	9.0	12.0	78.0	13	0	1	0	14	0.24	0	0.11	0.18
12	48.0	22.5	1.0	1.5	73.0	1	1	1	0	3	0.02	0.04	1.00	0.04
19	47.5	10.5	0	48.0	106.0	8	1	0	1	10	0.17	0.09	0	0.09
26	40.0	19.5	2.0	12.0	73.5	4	11	1	1	17	0.10	0.56	0.50	0.23
Jul 03	53.5	16.0	0.5	4.5	74.5	12	16	2	0	30	0.22	1.00	4.00	0.40
10	21.5	14.5	0	7.0	43.0	3	6	0	0	9	0.14	0.41	0	0.20
17	78.5	37.5	22.0	14.0	152.0	7	22	18	3	50	0.09	0.58	0.80	0.33
24	105.0	13.0	5.0	79.0	202.0	13	19	2	1	35	0.12	1.46	0.40	0.17
31	70.0	3.0	0.5	49.0	122.5	2	6	0	1	9	0.03	2.00	0	0.07
Aug 07	38.0	3.0	1.5	6.0	48.5	3	4	1	0	8	0.08	1.33	0.67	0.16
14	14.5	8.5	0	22.0	45.0	0	0	0	0	0	0	0	0	0
21	42.5	6.5	2.0	19.0	70.0	8	11	1	0	20	0.19	1.69	0.50	0.28
28	31.5	10.0	0	11.0	52.5	1	8	0	0	9	0.03	0.80	0	0.17
Sep 04	26.0	9.5	22.0	13.0	70.5	11	7	0	1	19	0.42	0.73	0	0.27
11	27.0	2.0	0	4.0	33.0	9	1	0	2	12	0.33	0.50	0	0.36
18	35.0	10.0	4.0	2.5	51.5	5	15	1	1	22	0.14	1.50	0.25	0.43
Total	763	241.5	69.5	304.5	1378.5	101	158	28	11	298			N/A	
Seasonal Means		N/A					N/A				0.13	0.74	0.68	0.22

[a] Humpback whitefish, burbot or non-specific effort.
[b] Humpback whitefish or burbot.

Table 7. Catch per unit effort by species, Marsh Lake, 1983.

Week Ending	NUMBER OF HOURS FISHED					NUMBER OF FISH CAUGHT				CATCH PER UNIT EFFORT			
	Lake Trout	Arctic Grayling	Northern Pike	Other[a]	Total	Lake Trout	Arctic Grayling	Northern Pike	Total	Lake Trout	Arctic Grayling	Northern Pike	All Species
June 18,19 (Kiwanis Derby)	N O T A V A I L A B L E					32	0	13	45	N O T A V A I L B L E			
Jul 24	0	1	1	1	3	0	4	2	6	0	4.0	2.00	2.0
31	0	13	9	3	25	0	51	4	55	0	3.9	0.43	2.2
Aug 07	0	5	0	0	5	0	5	0	5	0	1.0	0	1.0
14	0	17	0	5	22	0	10	1	11	0	0.59		0.5
21	2	0	0	0	2	0	0	0	0	0	0	0	0
28	0	13.5	15	2	30.5	0	7	9	16	0	0.52	0.6	0.52
Sep 04	0	5.5	4	0.5	10	0	11	3	14	0	2.75	0.75	1.40
11	14	0	0	0	14	2	0	0	2	0.14	0	0	0.14
18	0	10	0	3	13	0	10	0	10	0	1.0	0	1.3
25	0	1	0	0	1	0	2	0	2	0	2.0	0	2.0
Total	16	66	29	14.5	125.5	34	100	32	166			N/A	
Seasonal Means		N/A					N/A			0.14	1.9	0.9	1.1

[a] Humpback whitefish, burbot or non-specific effort.

Table 8. Catch per unit effort by species, Tagish Lake, 1983.

Week Ending	NUMBER OF HOURS FISHED					NUMBER OF FISH CAUGHT					CATCH PER UNIT EFFORT			
	Lake Trout	Arctic Grayling	Northern Pike	Other[a]	Total	Lake Trout	Arctic Grayling	Northern Pike	Other[b]	Total	Lake Trout	Arctic Grayling	Northern Pike	All Species
June 18,19 (Kiwanis Derby)	599.0	10	15	0	624	134	2	22	0	158	0.22	0.2	1.47	0.25
Jul 17	169.0	0	0	0	169.0	37	0	0	0	37	0.22	0	0	0.22
24	103.5	0	0	0	103.5	7	0	0	0	7	0.06	0	0	0.06
31	143.0	0	0	0	143.0	5	0	0	0	5	0.03	0	0	0.03
Aug 07	82.5	0	4	4	90.5	9	9	4	0	13	0.10	0	1.00	0.14
14	74.5	0	0	6.5	81.0	20	2	1	0	23	0.26	0	0	0.21
21	15.0	0	0	0	15.0	2	0	0	0	2	0.13	0	0	0.13
28	41.5	0	0	0	41.5	9	0	0	0	9	0.21	0	0	0.21
Sep 04	77.0	0	0	1	78.0	23	0	0	0	25	0.30	0	0	0.30
11	126.0	0	0	24	150.0	8	0	1	0	9	0.06	0	0	0.06
18	4.5	0	0	0	4.5	0	0	0	0	0	0	0	0	0
Total	1435.5	10	19	35.5	1500.0	254	4	28	2	288			N/A	
Seasonal Means		N/A					N/A				0.14	0.20	1.24	0.15

a Least cisco or non-specific effort.
b Least cisco.

due to the variation in water conditions and angler characteristics. Therefore, the total hours spent fishing reported for Marsh and Tagish lakes largely underestimate the total fishing effort during 1983.

As described in the methods, the C.P.U.E. levels were calculated for each species using hours of effort expended specifically for that species. For example, if a grayling was caught when specifically fishing for a lake trout, the hours of effort expended for grayling were considered to be zero. If, however, a grayling was caught when the angler was fishing for "anything at all", those hours and fish numbers were included under "other or non-specific" and no C.P.U.E. value was calculated. Although this approach may be somewhat confusing initially, the elimination of non-specific effort was found to be the most accurate approach to determining the species specific success levels.

At Fox Lake, the highest C.P.U.E. was obtained for grayling, with a seasonal mean of 0.74 fish/hour, followed by 0.68 fish/hour for pike and 0.13 fish/hour for lake trout. The seasonal mean for all species combined, including whitefish and burbot was 0.22 fish/hour (Fig. 3, Table 6). The C.P.U.E. values for lake trout at Fox Lake showed little in-season variation, although there appeared to be a slight increase towards late August and early September (Fig.3). This was unlike the 1981 results where June was the most successful fishing month (D'Estimauville 1981). Success levels fluctuated seasonally for grayling and pike but no clear trend was apparent.

At Marsh Lake, the recorded mean seasonal C.P.U.E values were 1.9 fish/hour for grayling and 0.9 fish/hour for pike (Table 7). Data on lake trout were insufficient to provide a reliable indicator of overall seasonal success. Seasonal variation in the grayling C.P.U.E. indicated a greater success level during July (Table 7).

At Tagish Lake, the highest C.P.U.E. was obtained for pike with a seasonal mean of 1.24 fish/hour, followed by 0.20 fish/hour for grayling and 0.14 fish/hour for lake trout (Table 8). However, the data for each of pike and grayling were obtained over a one week period and were therefore not representative of the seasonal potential. The C.P.U.E. levels for lake trout fluctuated somewhat from week-to-week with a general increase observed towards late August and early September (Fig.4) possibly corresponding to timing of spawning when increased fish aggressiveness leads to increased vulnerability to anglers. The weekend of the derby showed an above average C.P.U.E. for lake trout of 0.22 fish/hour. However, this was well within the range of seasonal values despite the obviously intensive effort exerted during this period (Table 8).

General lake-to-lake comparisons were made between C.P.U.E. levels for grayling in Fox and Marsh lakes and for lake trout in Fox and Tagish lakes. The higher mean value for grayling of 1.9 fish/hour in Marsh Lake compared to 0.7 fish/hour in Fox Lake likely reflects either a greater grayling population in Marsh Lake, or a better access by fishermen to those areas in Marsh Lake preferred by grayling resulting in greater fish vulnerability, or a combination of the two factors. For example, long stretches of shoreline at the Lewes River

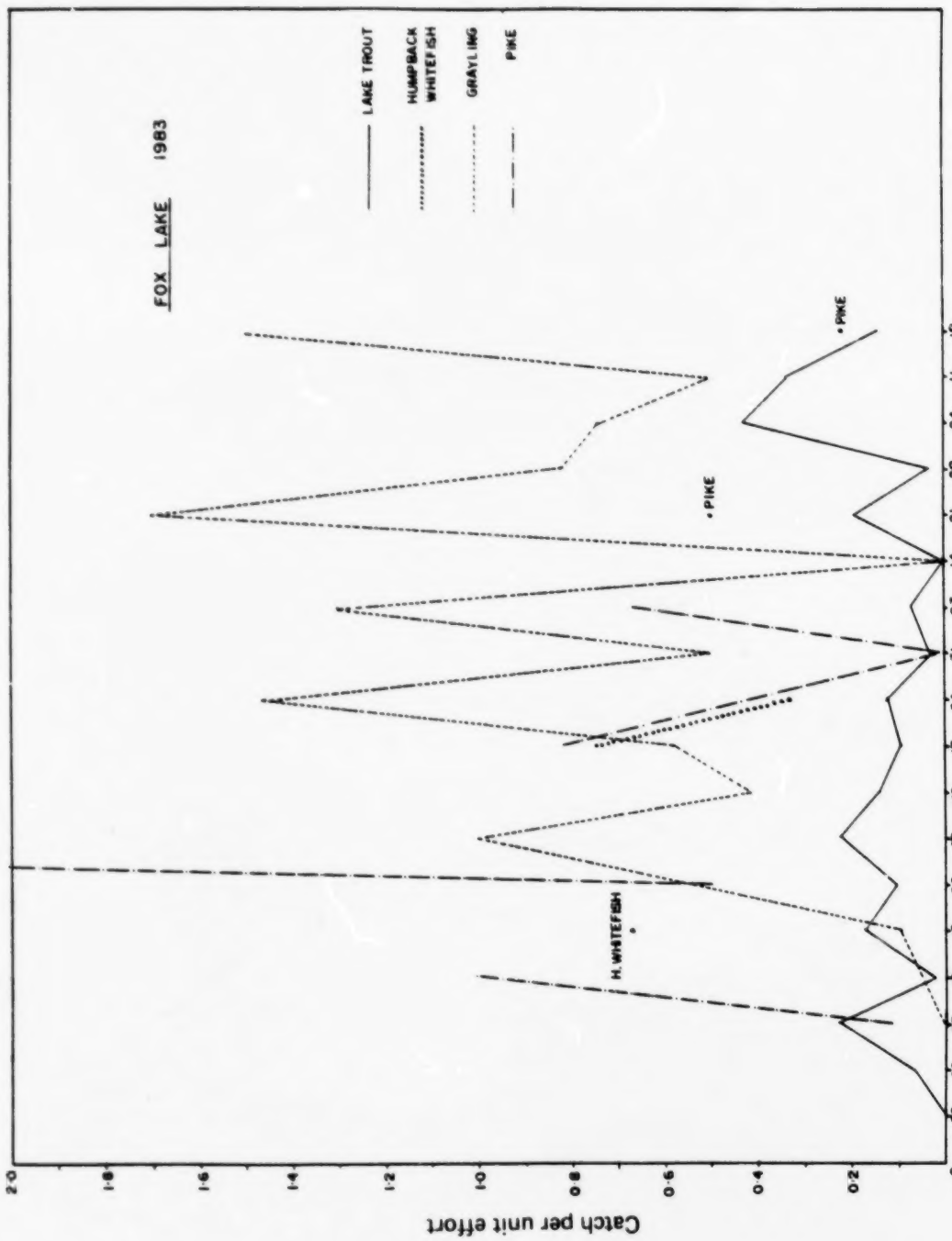

Fig. 3. Seasonal catch per unit effort (No. fish caught / hr) for each species captured in Fox Lake, 1983.

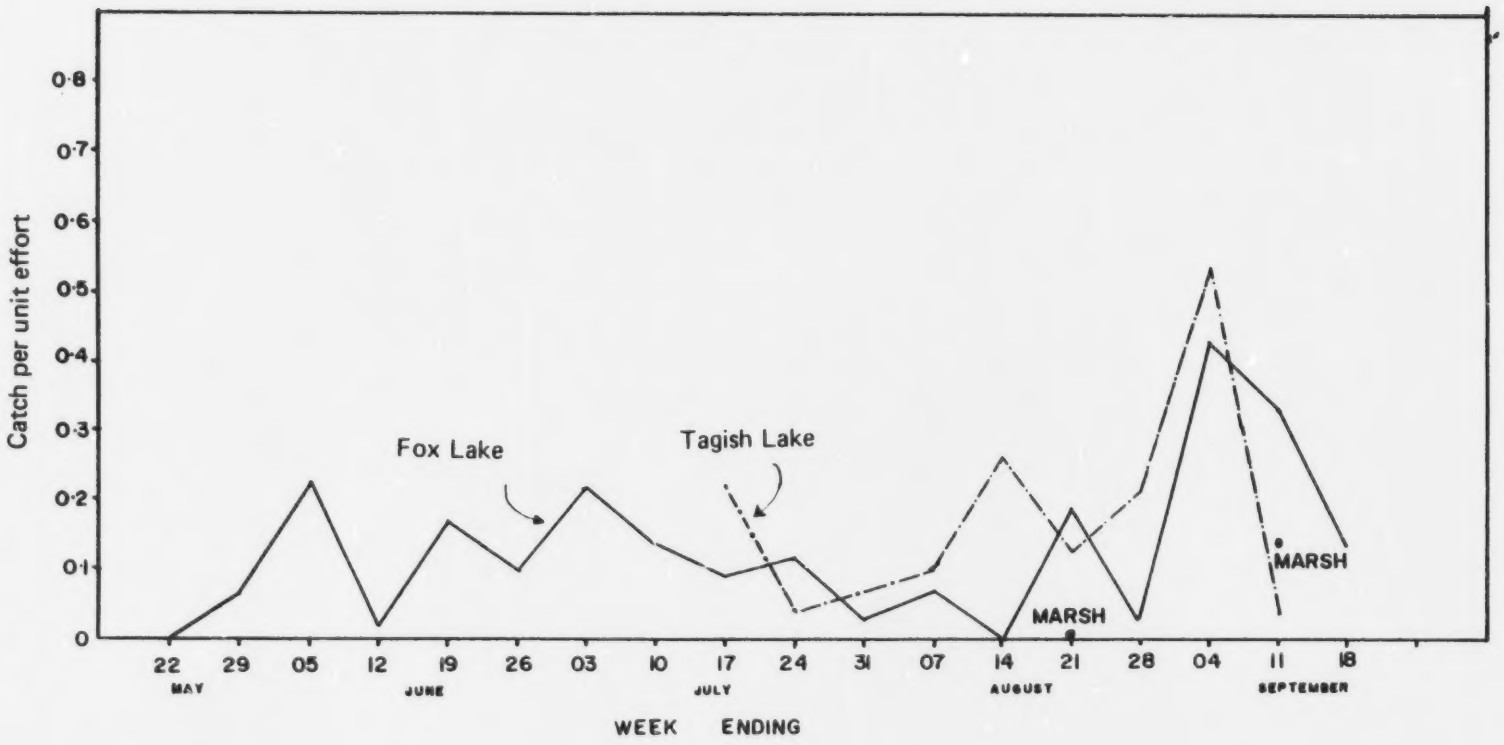

Fig. 4. Seasonal catch per unit effort (No. fish caught / hr) for lake trout captured in Fox, Marsh and Tagish lakes, 1983.

Bridge and McClintock Bay in Marsh Lake provide the angler with many opportunities for successful grayling fishing, whereas such access is more restricted at Fox Lake.

Although seasonal mean C.P.U.E.'s were quite similar for lake trout from Fox and Tagish Lakes, 0.13 and 0.14 fish/hour respectively, initially these data were felt to be incomparable due to variation in survey periods (Tables 6 and 8). However, further examination of the common interval from July 17 to September 18 also showed an identical C.P.U.E. level of 0.14 fish/hour for both lakes (Fig. 4). Since Tagish Lake is known to be more heavily utilized during June and early July compared to later months, a survey during that period would be required to assess the overall C.P.U.E. status.

Angler residency

In all three lakes studied, the majority of anglers were Yukon residents (54% to 78%), followed by U.S. (13% to 32%) and non-Yukon Canadian (6% to 10%) residents (Table 9). Yukon residents generally outnumbered the tourists two to one. The seasonal data indicated that non-Yukon anglers were commonly encountered throughout July to September (Fig.5).

BIOLOGICAL INVESTIGATIONS

In interpreting the results of the biological investigations, the possible effects of angler and sampling selectivity must be considered. Among the Fox Lake catch, all but two of the lake trout caught during the survey period were retained, providing a good representation of the size range selected by the sport fishery. Half of the trout catch or 50 fish were subsampled randomly. Of the 52 retained grayling at Fox Lake, 35 were subsampled randomly. Anglers released the grayling for several reasons: possession limit was already filled, fish were below the minimum size allowed, were undesirable by specific fishermen, or were caught just for angling.

Fishermen at Marsh and Tagish lakes generally kept all the lake trout they caught. Excluding the catches tabulated during the residential interviews, 90% of the trout caught in Marsh Lake and 57% caught in Tagish Lake were sampled. However, in both of these lakes a substantial proportion of the trout were sampled during the fishing derby. Since the fishermen involved generally entered the largest fish in their catch, the distribution of the trout length and weight data was biased toward the larger fish. Biological information for grayling in Marsh Lake was gathered during the routine interviewing procedure.

Size, age and condition

The means and ranges for age, weight and length of the lake trout sampled at Fox, Marsh and Tagish lakes are presented in Table 10. The age range of the trout catch showed similar lower limits among the three lakes but different upper limits by several years. Since the sampling effort was more intensive during the derby which was biased towards larger fish, it is likely that the trout samples from Marsh and Tagish lakes included many of the older age

Table 9. Angler residency status for Fox, Marsh and Tagish lakes, 1983.

Residency	Fox Lake		Marsh Lake		Tagish Lake		All Lakes	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Yukon residents	270	(54.4)	178	(71.5)	50	(78.1)	498	(61.6)
Non-Yukon Canadians	48	(9.7)	22	(8.8)	4	(6.3)	74	(9.1)
U.S. residents	157	(31.7)	48	(19.3)	8	(12.5)	213	(26.3)
Others	21	(4.2)	1	(0.4)	2	(3.1)	24	(3.0)
Total [a]	496	(100)	249	(100)	64	(100)	809	(100)

[a] Total anglers interviewed in which residency was determined.

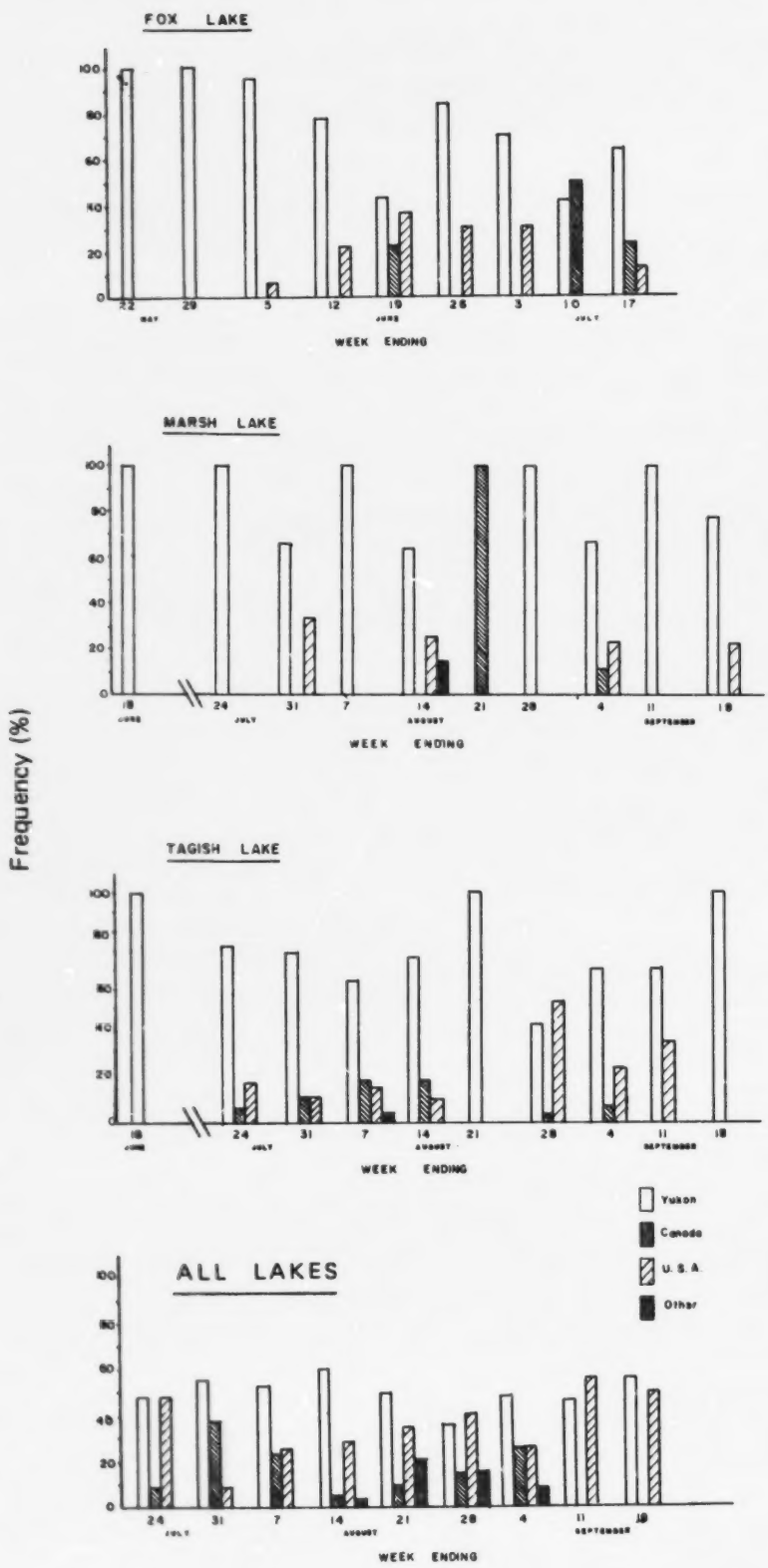

Fig. 5. Angler origin for Fox, Marsh and Tagish lakes and for all lakes combined, 1983.

Table 10. Summary of age, weight, length and condition for lake trout sampled at Fox, Marsh and Tagish lakes, 1983.

PARAMETER		FOX	MARSH	TAGISH
Age -	range (years)	6-17	8-27	7-39
	mean	9.3	13.5	12.9
	mode	9	11	11
Weight -	range (g)	200-1620	907-3288	822-8221
	mean	729	1588	1840
Length -	range (mm)	225-521	430-634	385-940
	mean	390	510	535
K -	range	0.92-1.43	0.88-1.51	0.63-2.48
	mean	1.16	1.15	1.10

Table 11. Summary of age, weight, length and condition for grayling sampled at Fox and Marsh lakes, 1983.

PARAMETER		FOX	MARSH
Age -	range (years)	1-8	3-5
	mean	3.9	4.0
	mode	4	4
Weight -	range (g)	75-650	100-250
	mean	412	193
Length -	range (mm)	196-395	220-289
	mean	336	255
K -	range	0.52-1.36	0.82-1.41
	mean	1.03	1.10

classes. The mean trout ages were 13.5 years for Marsh Lake and 12.9 years for Tagish Lake, both values being somewhat higher than the mean age of 9.3 years for Fox Lake trout (Table 10).

Trends similar to the above were also apparent in the mean weight and length data for lake trout (Table 10). The length and weight frequency distributions of the trout catch in Fox, Marsh and Tagish lakes are shown in Figures 6, 8 and 9 respectively. Tagish Lake had the largest trout with the greatest size range (mean weight 1.8 kg, range 0.8 - 8.2 kg; mean length 53.5 cm, range 38.5 - 94.0 cm), while Fox Lake had the smallest trout size (mean weight 0.7 kg, range 0.2 - 1.6 kg; mean length 39.0 cm, range 22.5 - 52.1 cm).

As previously mentioned, the larger size of lake trout observed in Tagish Lake catch may have been partly due to the release of small fish during the fishing derby. At first it was suspected that the smaller mean size of the lake trout catch in Fox Lake may have been influenced to some extent by angler behavior since much of the fishing was done from shore. Few boats were in use at Fox Lake which limited the access to deeper portions of the lake. However, a comparison of the angled Fox Lake trout with those captured during a gillnetting program (Horler et al. 1983) showed a similar size distribution (Figs. 6 and 7), indicating that Fox Lake anglers did catch fish of a size representitve of the lake population.

A summary of the means and ranges of age, weight and length for Arctic grayling sampled at Fox and Marsh lakes is presented in Table 11. The length and weight frequency distributions of the grayling catch in Fox and Marsh lakes are presented in Figures 10 and 11 respectively. The range of ages represented in the grayling catch from Fox Lake (1-8 years) was greater than that of Marsh Lake (3-5 years). However, the modal ages were very similar and the mean age of four years was the same for the two lakes (Table 11). The range of grayling weights and lengths was also higher for Fox compared to Marsh Lake, and the difference was attributed to the greater representation of age classes in the Fox Lake catch. Grayling sampled from Fox Lake were generally larger (mean size 0.4 kg and 33.6 cm) than the Marsh Lake samples (mean size 0.2 kg and 25.5 cm; Table 11). The significance of the apparent smaller size of Arctic grayling in Marsh Lake should be investigated further.

Age-specific mean lengths and weights for lake trout from Fox, Marsh and Tagish lakes are presented in Tables 12 a and b. The results of the Distribution Free Multiple Comparison Test showed that lake trout from Marsh and Tagish lakes had significantly higher (at the 95% confidence level) growth rates compared to Fox Lake. These differences were also apparent from the growth curves derived for each lake (Figs. 12 a and b).

An examination of the factors contributing to the above variation was beyond the scope of the current study. Although all three lakes have a history of fishing, it is believed that Marsh and Tagish lakes have been continuously exploited for a longer period and at a heavier level than Fox Lake. This high harvest may have been sufficiently intense to result in accelerated growth rates in Marsh and Tagish lakes. However, since no information exists on the status of the original unexploited population, it is not possible to assess the extent of any change associated with fishing activities.

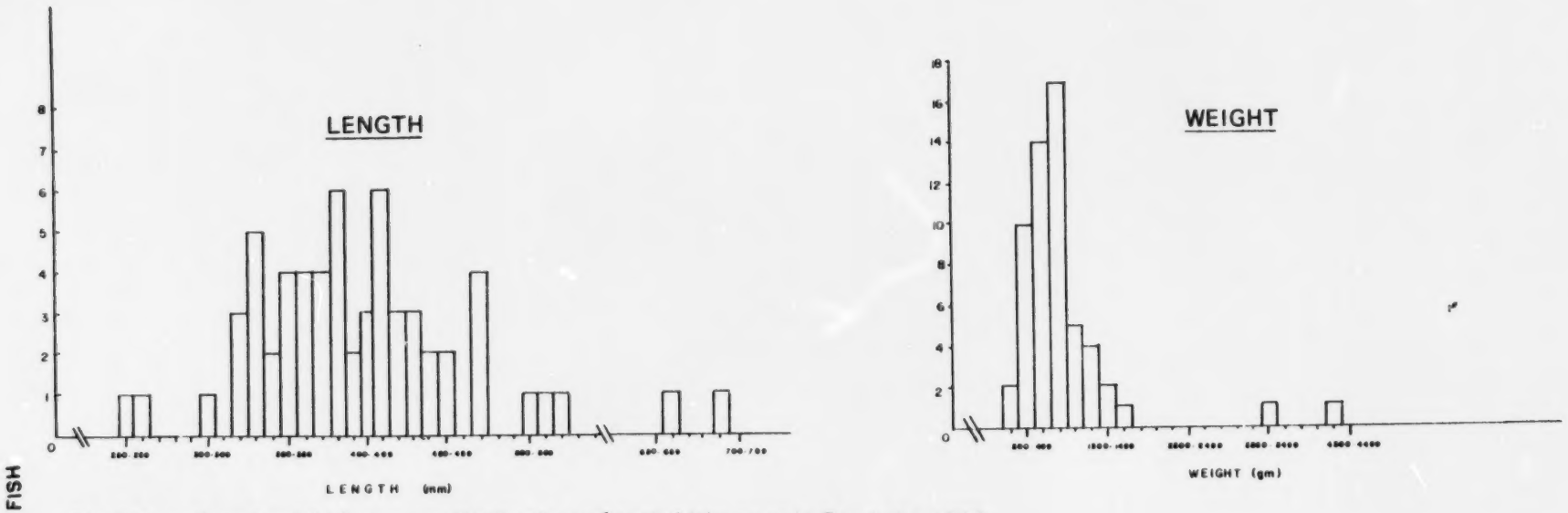

Fig. 6. Length and weight frequency distributions of angled lake trout in Fox Lake, 1983.

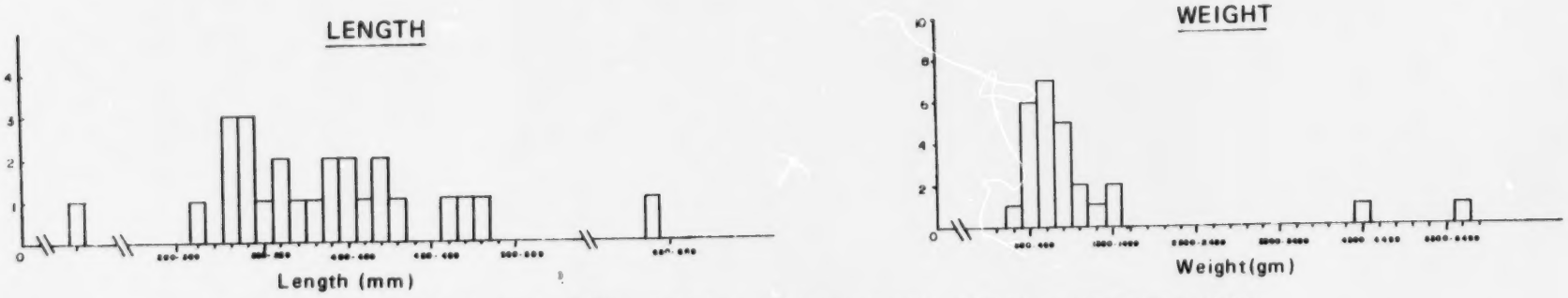

Fig. 7. Length and weight frequency distributions of gillnetted lake trout in Fox Lake, 1983 (from Horler et al. 1983).

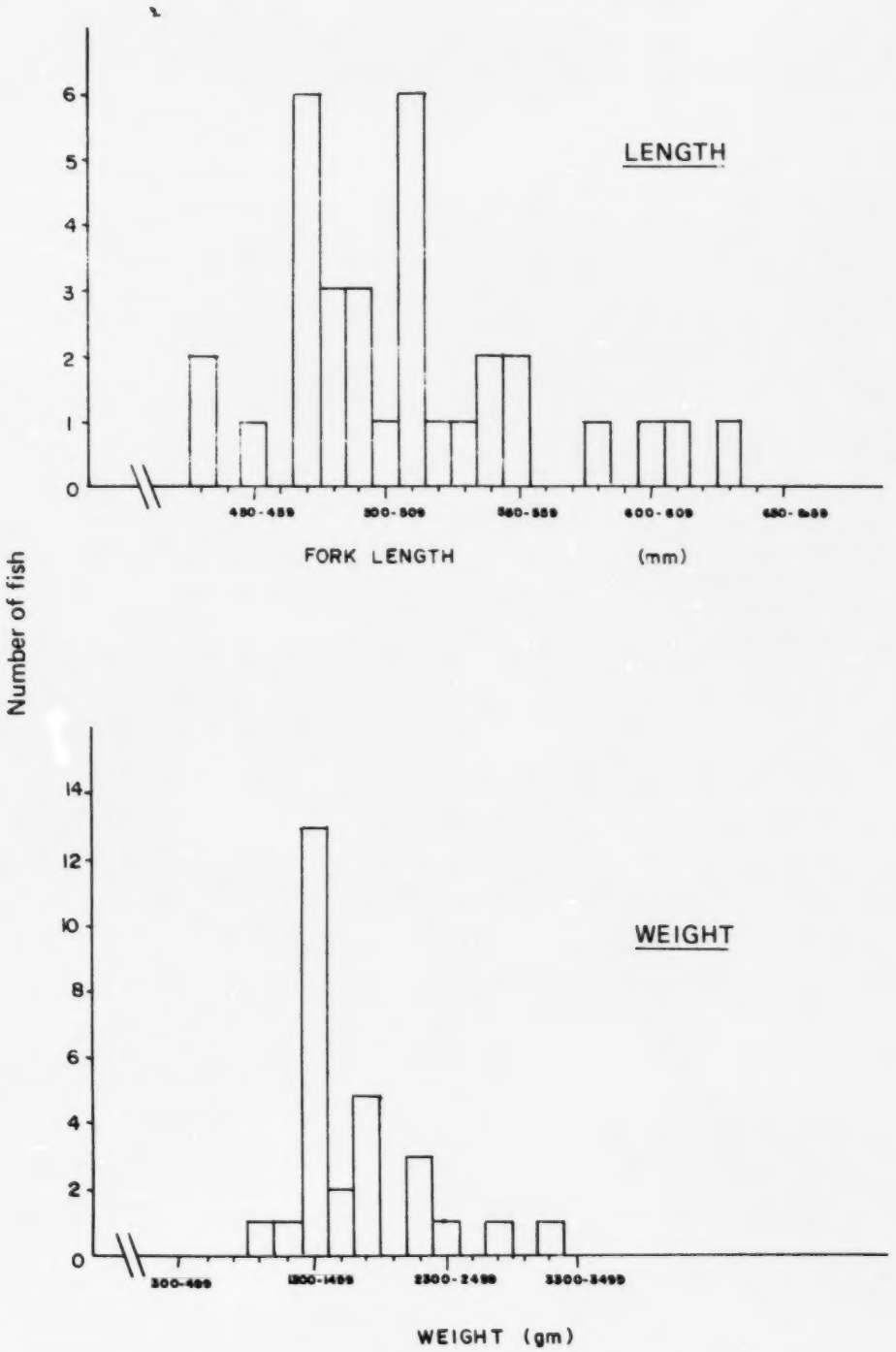

Fig. 8. Length and weight frequency distributions of angled lake trout in Marsh Lake, 1983.

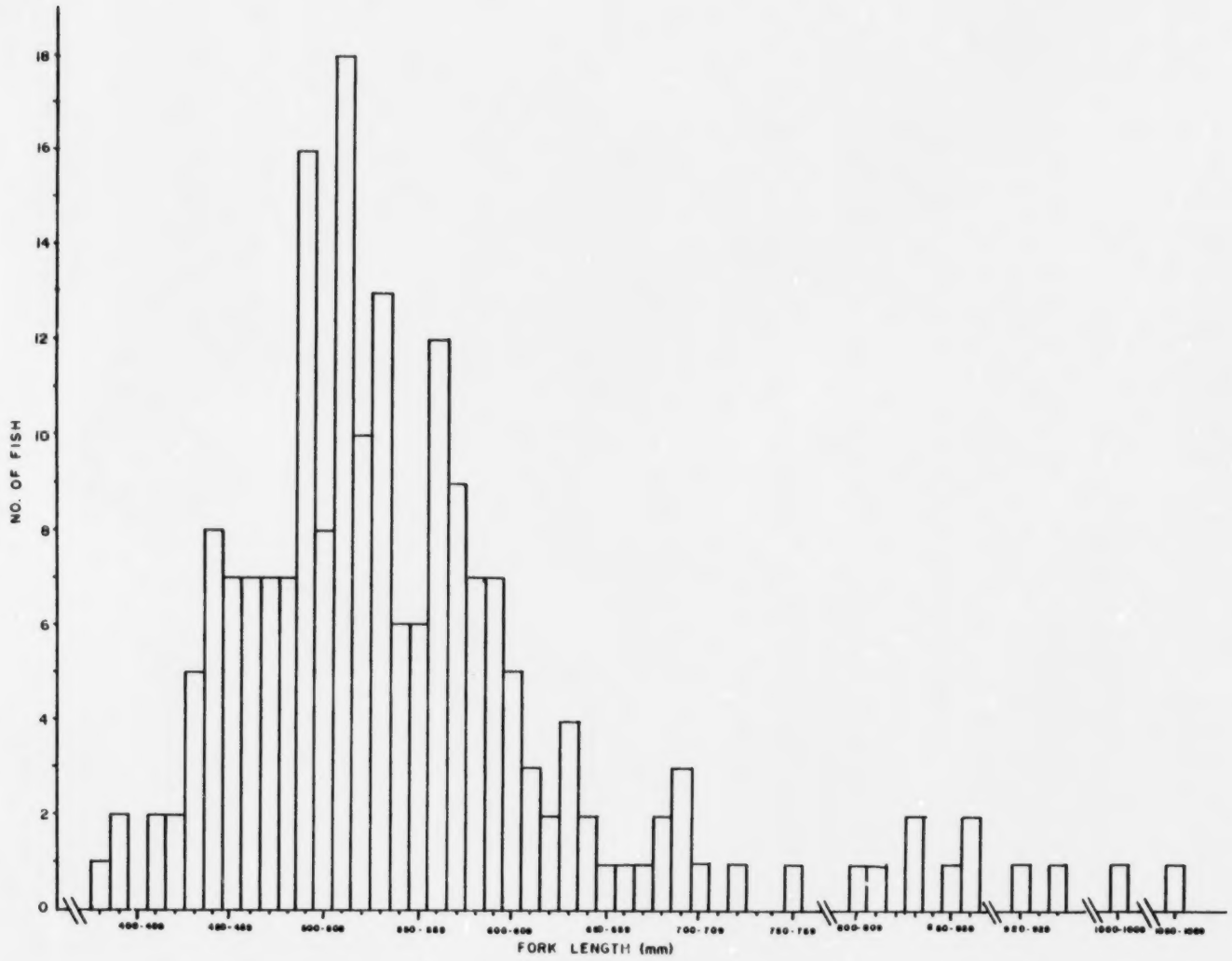

Fig. 9a. Length frequency distribution of angled lake trout in Tagish Lake, 1983.

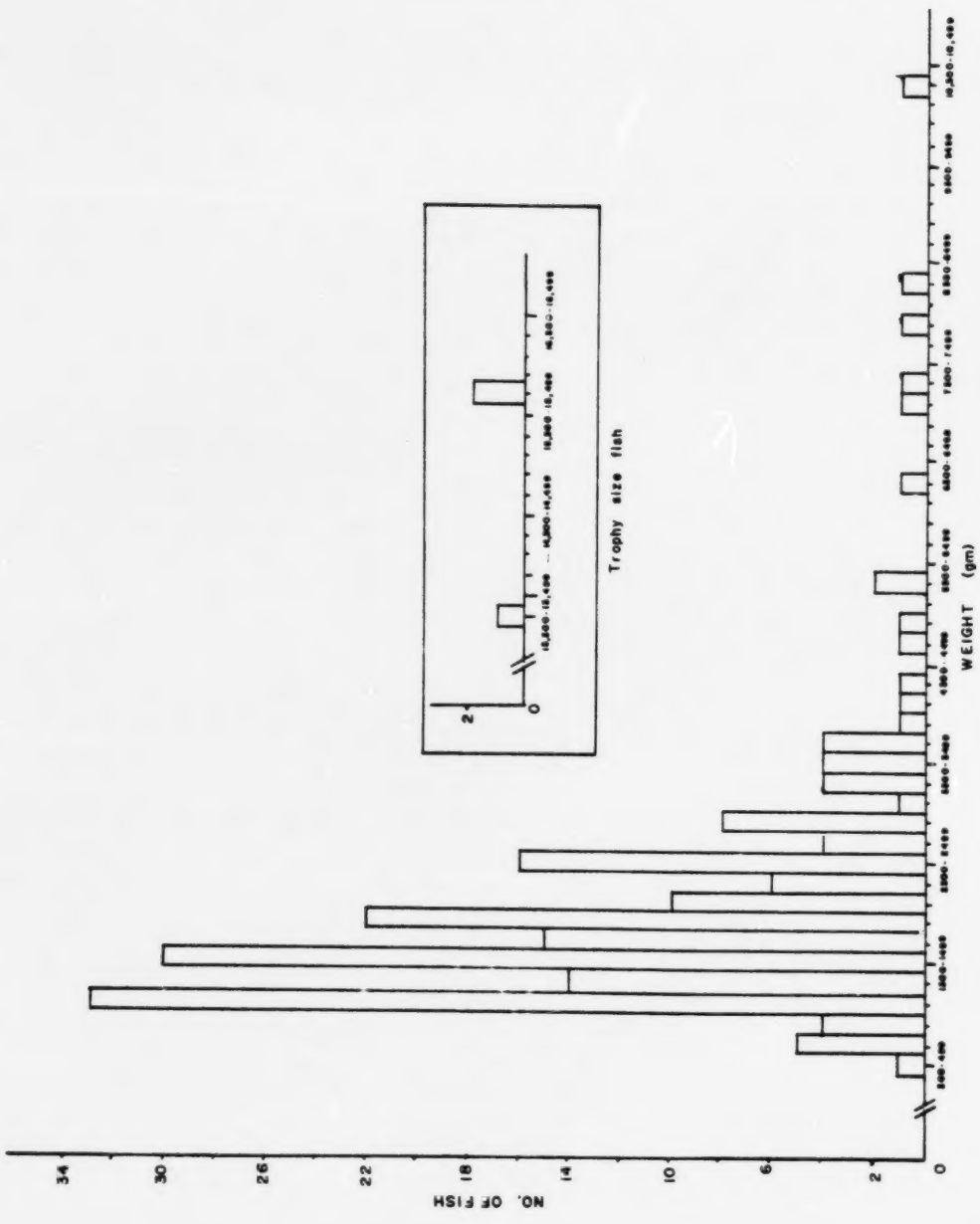

Fig. 9b. Weight frequency distribution of angled lake trout in Tagish Lake, 1983.

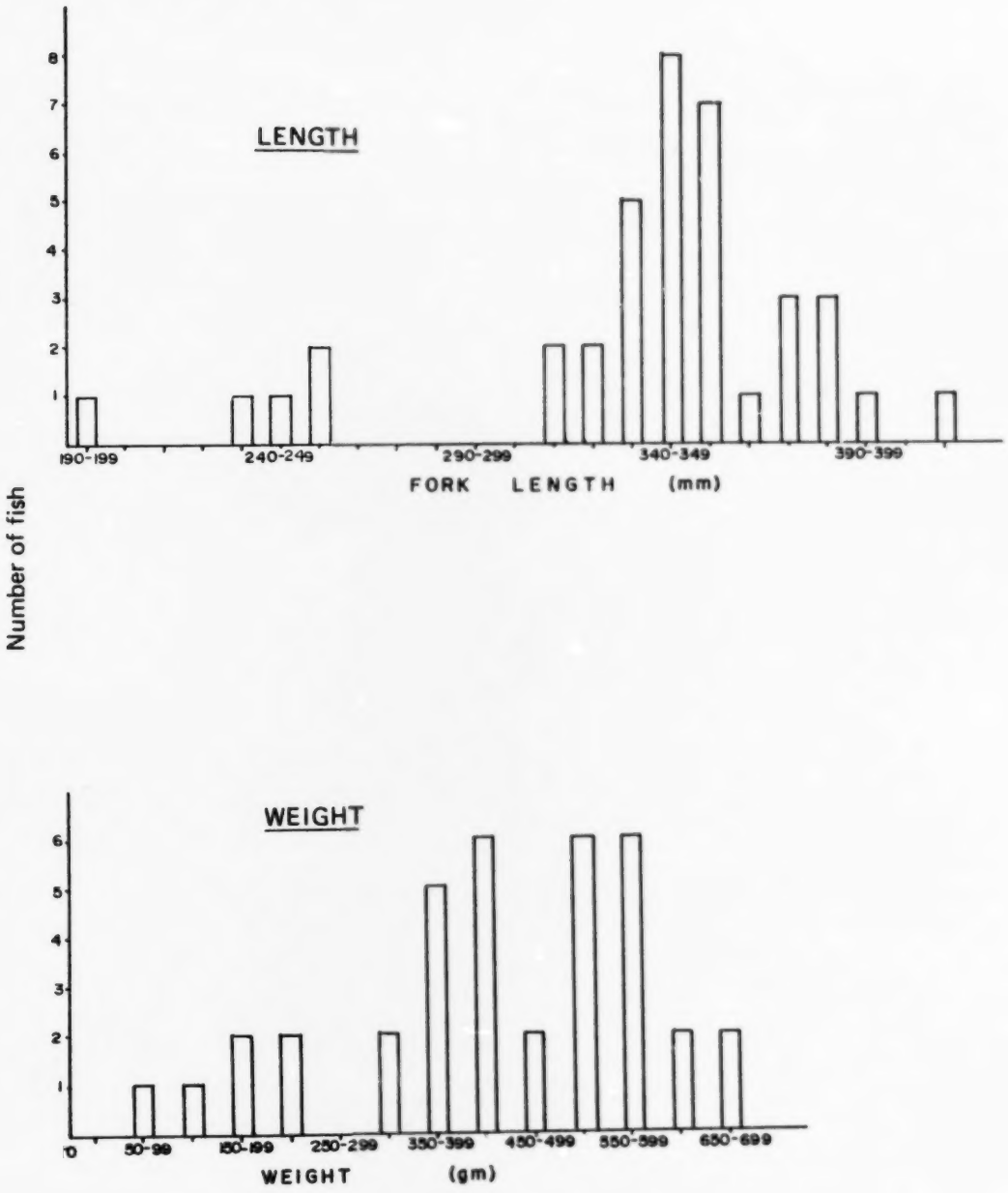

Fig. 10. Length and weight frequency distributions of angled Arctic grayling in Fox Lake, 1983.

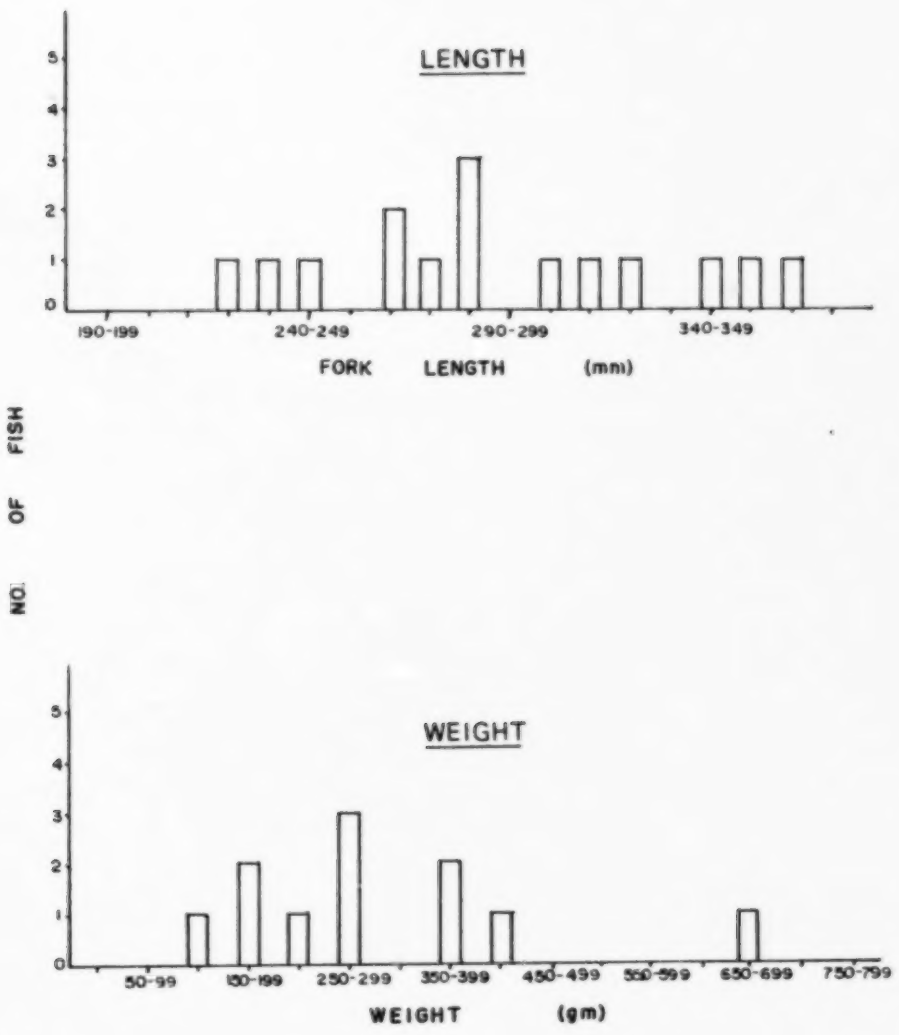

Fig. 11. Length and weight frequency distributions of angled Arctic grayling in Marsh Lake, 1983.

Table 12a. Age-specific lengths, weights and condition for lake trout from Fox and Marsh lakes, 1983 (N gives sample size).

LAKE	AGE (years)	N	Fork Length (mm)			Weight (gm)			K		
			Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
FOX	6	2	285	84.9	225-345	288	123.7	200-375	1.06	0.21	0.91-1.21
	7	6	341	58.7	265-439	488	237.1	200-880	1.15	0.12	1.04-1.31
	8	5	366	23.9	331-391	538	152.9	400-825	1.14	0.15	0.99-1.38
	9	13	399	50.7	334-445	755	262.2	400-1150	1.15	0.13	0.92-1.40
	10	10	403	34.0	349-453	763	200.4	520-1150	1.15	0.08	0.98-1.26
	11	3	469	57.0	408-521	1217	236.3	950-1300	1.20	0.21	0.99-1.40
	12	2	395	40.3	366-423	755	106.1	700-850	1.28	0.22	1.12-1.43
	13	0	-	-	-	-	-	-	-	-	-
	14	1	508	-	-	1620	-	-	1.24	-	-
	15	0	-	-	-	-	-	-	-	-	-
	16	0	-	-	-	-	-	-	-	-	-
	17	1	413	-	-	890	-	-	1.26	-	-
MARSH	8	2	463	17.7	450-475	1114	268.7	924-1304	1.12	0.15	1.01-1.22
	9	3	474	40.0	435-515	1200	257.3	907-1389	1.12	0.11	1.02-1.24
	10	3	480	52.7	430-535	1085	26.3	932-1389	0.99	0.17	0.88-1.18
	11	7	492	17.2	469-515	1340	217.4	935-1672	1.09	0.11	0.91-1.25
	12	2	510	0	-	1715	20.5	1700-1729	1.29	0.01	1.28-1.30
	13	2	535	68.6	486-583	1843	641.4	1389-2296	1.19	0.04	1.16-1.21
	14	1	470	-	-	935	-	-	0.90	-	-
	15	4	531	25.1	499-552	1806	331.9	1384-2182	1.2	0.09	1.11-1.23
	16	2	575	48.8	540-609	2636	360.6	2381-2891	1.40	0.16	1.28-1.51
	17	1	492	-	-	1448	-	-	1.31	-	-
	18	0	-	-	-	-	-	-	-	-	-
	19	0	-	-	-	-	-	-	-	-	-
	20	0	-	-	-	-	-	-	-	-	-
	21	1	610	-	-	2286	-	-	1.01	-	-
	22	0	-	-	-	-	-	-	-	-	-
	23	0	-	-	-	-	-	-	-	-	-
	24	1	634	-	-	3288	-	-	1.29	-	-
	25	1	475	-	-	1360	-	-	1.27	-	-
	26	0	-	-	-	-	-	-	-	-	-
	27	1	540	-	-	1822	-	-	1.16	-	-

Table 12b. Age-specific lengths, weights and condition for lake trout from Tagish Lake, 1983 (N gives sample size).

LAKE	AGE (years)	N	Fork Length (mm)			Weight (gm)			K		
			Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
TAGISH	7	1	480	-	-	1200	-	-	1.09	-	-
	8	11	503	55.0	438-617	1504	632.8	850-2764	1.16	0.15	0.92-1.41
	9	20	499	44.1	432-580	1450	648.1	822-3668	1.14	0.34	0.70-2.48
	10	20	502	64.5	395-645	1426	665.9	912-3245	1.06	0.24	0.68-1.86
	11	22	489	35.7	417-543	1222	261.8	932-1700	1.06	0.24	0.63-1.60
	12	11	510	39.2	454-561	1460	448.4	850-2069	1.07	0.16	0.81-1.28
	13	21	523	51.7	385-590	1607	567.3	538-2494	1.07	0.17	0.71-1.27
	14	15	558	73.6	439-724	2056	909.8	921-4222	1.12	0.15	0.80-1.36
	15	12	585	76.5	510-807	2389	917.6	1800-5131	1.17	0.13	0.98-1.36
	16	13	540	42.6	480-597	1598	537.6	921-2721	0.98	0.15	0.71-1.33
	17	4	605	179.6	467-862	3326	3015.0	1247-7711	1.25	0.10	1.17-1.40
	18	4	585	104.6	482-691	2559	1515.8	935-3900	1.14	0.23	0.83-1.37
	19	5	687	98.8	610-857	3930	1931.6	2353-7283	1.15	0.07	1.04-1.21
	20	1	575	-	-	2438	-	-	1.28	-	-
	21	2	629	43.8	598-660	2675	94.1	2608-2741	1.09	0.20	0.95-1.22
	22	0	-	-	-	-	-	-	-	-	-
	23	2	603	41.7	573-632	2598	226.3	2438-2758	1.2	0.15	1.09-1.30
	24	0	-	-	-	-	-	-	-	-	-
	25	0	-	-	-	-	-	-	-		-
	26	1	940	-	-	8221	-	-	0.99	-	-
	27	0	-	-	-	-	-	-	-	-	-
	28	0	-	-	-	-	-	-	-	-	-
	29	1	683	-	-	4620	-	-	1.45	-	-
	30	0	-	-	-	-	-	-	-	-	-
	31	0	-	-	-	-	-	-	-	-	-
	32	0	-	-	-	-	-	-	-	-	-
	33	0	-	-	-	-	-	-	-	-	-
	34	0	-	-	-	-	-	-	-	-	-
	35	0	-	-	-	-	-	-	-	-	-
	36	0	-	-	-	-	-	-	-	-	-
	37	0	-	-	-	-	-	-	-	-	-
	38	0	-	-	-	-	-	-	-	-	-
	39	1	756	-	-	6095	-	-	1.41	-	-

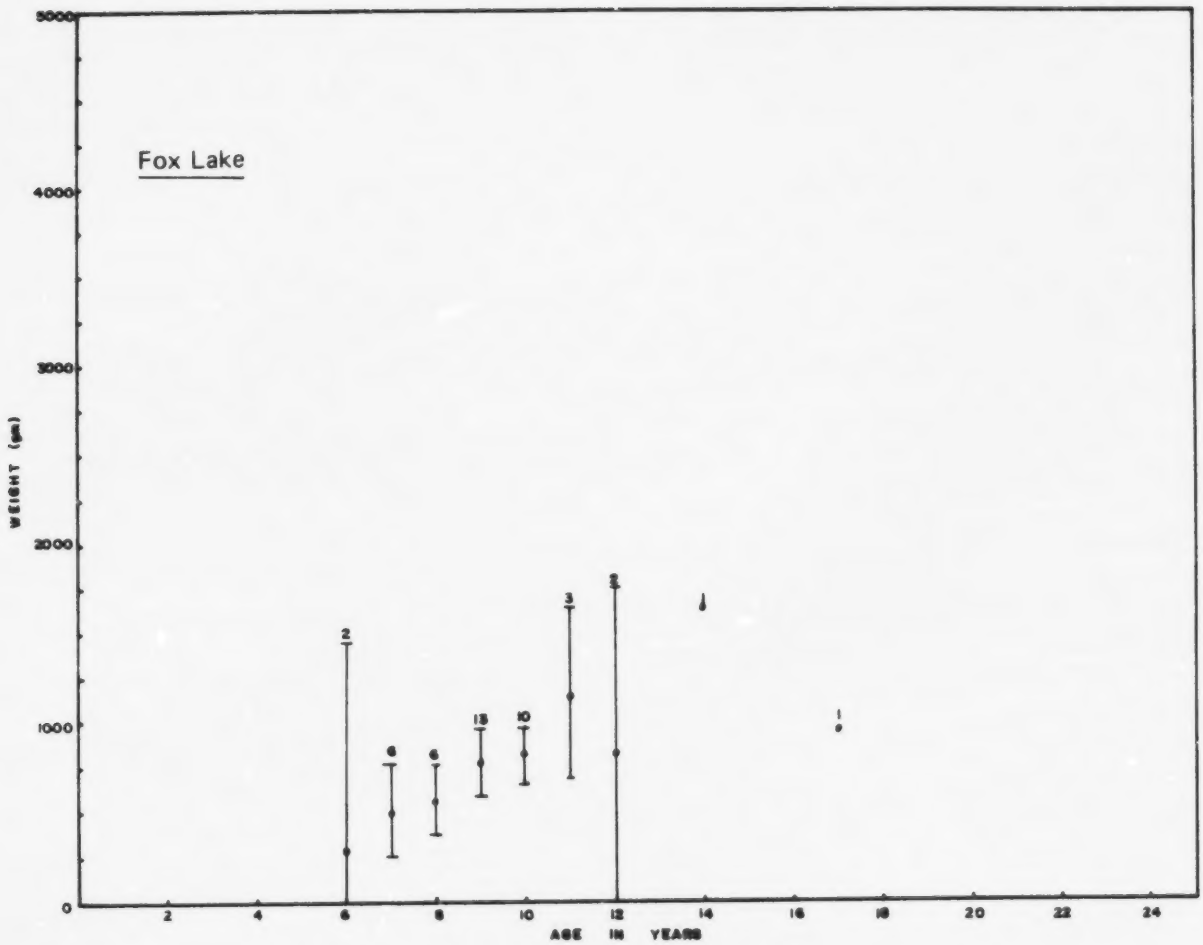

Fig. 12a. Relationship between age and weight of lake trout from Fox Lake, 1983 (±95% confidence limits and sample sizes are indicated).

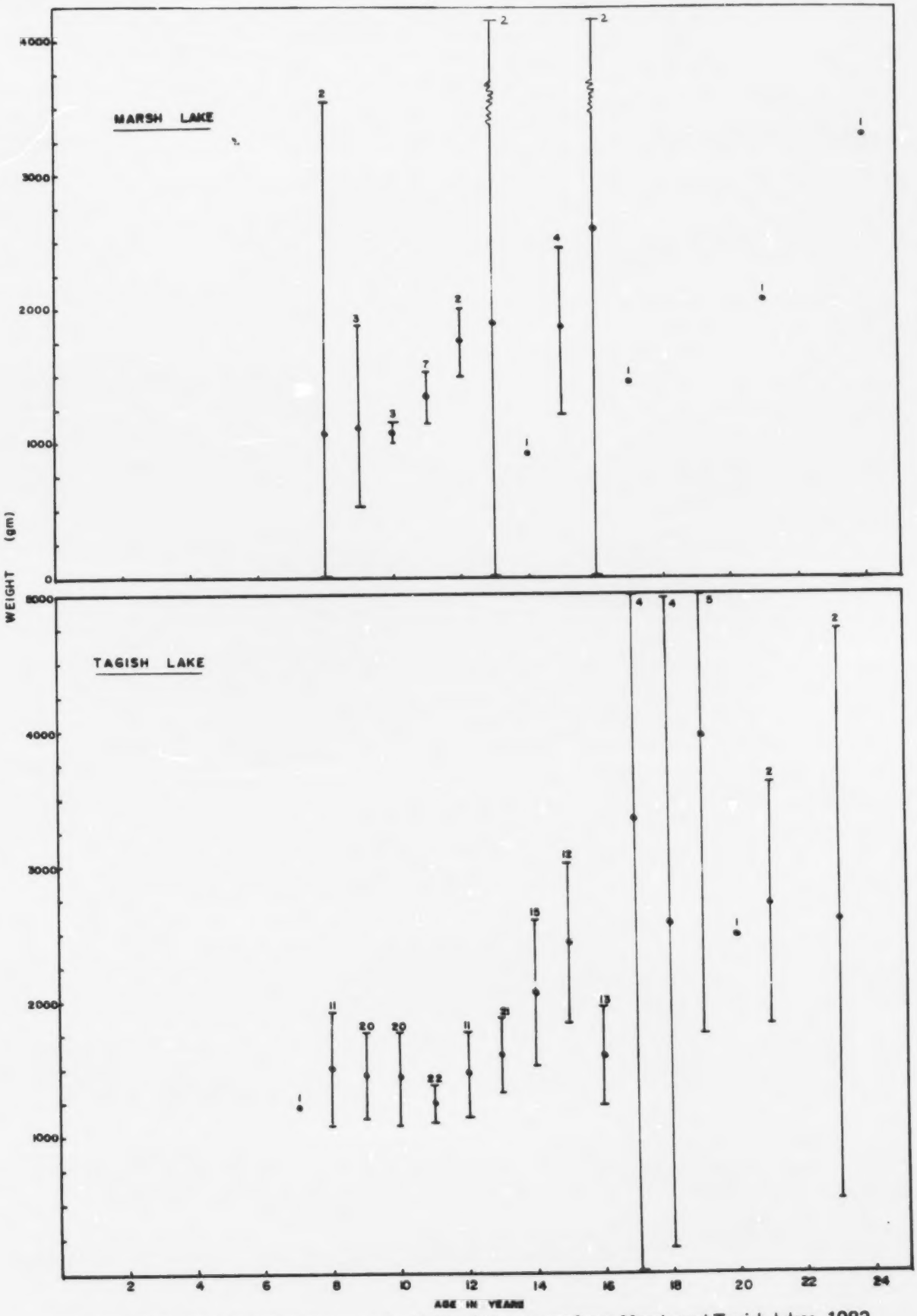

Fig. 12b. Relationship between age and weight of lake trout from Marsh and Tagish lakes, 1983 (± 95 % confidence limits and sample sizes are indicated).

MEI values ranged from 7.45 in Fox Lake to 4.69 in Marsh Lake to 1.22 in Tagish Lake. This trend in the MEI values indicates an inverse relationship with the growth rates of lake trout ie. the greater the growth rate, the lower the MEI. A similar trend was seen for lake trout in other Yukon Lakes (Horler et al.1983).

The harvest levels estimated in the present study were compared to the previously determined harvest guidelines (Horler et al.1983). For Fox Lake the values per species were as follows:

Species	Guideline	1983 Estimate
lake trout	677 kg	80 kg
Arctic grayling	472 kg	23 kg
northern pike	220 kg	10 kg

For Marsh and Tagish lakes only the lake trout guideline values were available based on a tentative harvest rate of 0.5 kg/ha/year (Horler et al.1983). For Marsh Lake the guideline and estimated 1983 lake trout harvests were 4,815 kg and 340 kg respectively, and for Tagish Lake these were 17,700 kg and 908 kg respectively. The above comparisons show that in all cases the estimated 1983 harvests were below the recommended quota. This was undoubtedly related to the poor weather conditions that prevailed during the 1983 fishing season, and to the incomplete harvest data for Marsh and Tagish lakes.

Age-specific mean lengths and weights for Arctic grayling from Fox Lake are presented in Table 13. A small sample size obtained at Marsh Lake precluded extensive age analysis. However, length and weight frequency distributions for the two lakes indicated that the grayling caught in Fox Lake were generally comparatively larger (Figs. 10 and 11). In a comparison between grayling sizes in sport catches in the Northwest Territories (Falk and Gillman 1980; Falk et al.1982) and those in Fox Lake, the Fox Lake samples were found to contain smaller and younger fish. The possibility of a small size bias in the Fox Lake sport sample was discounted since a similar size distribution was reported in a gillnetting program also conducted in 1983 (Horler et al.1983). However, within the age classes present, the growth of grayling was found to be greater from year-to-year in Fox Lake (Fig. 13) compared to results from other studies noted above.

The occurrence of comparatively higher growth rate but smaller and younger fish in Fox Lake may be indicative of heavy exploitation. If the size of the catch falls below the age of maturity, a serious overfishing may be indicated. Horler et al.(1983) found that Fox Lake graylings have a mean age of maturity of five years, and a mean size at that age of 36.9 cm and 549 g. By comparison, the Fox Lake grayling sampled in the present study were generally under five years of age with a mean size of only 33.6 cm and 412 g (Table 11). Therefore, the majority of the grayling captured in Fox Lake were composed of immature fish signifying that the Fox Lake grayling may be in danger of being overharvested.

Mean condition (K) values for each lake are summarized in Table 10 for lake trout and in Table 11 for grayling. Condition values calculated by age class are presented in Tables 12 a and b for lake trout and in Table 13 for grayling. The mean K values for lake trout of 1.16 in Fox Lake, 1.15 in Marsh Lake and 1.10 in Tagish Lake fell within the range derived for other Yukon lakes (Horler et al.1983). The mean K values for grayling of 1.03 in Fox Lake and

Table 13. Age specific lengths, weights and condition for Arctic grayling from Fox Lake, 1983 (N gives sample size).

AGE (years)	N	Fork Length		Weight(gm)		K	
		Mean	SD	Mean	SD	Mean	SD
1	1	250	-	150	-	1.04	-
2	3	256	73.5	125	66.0	1.40	0.38
3	6	325	41.0	379	126.9	0.94	0.14
4	14	345	12.9	436	80.1	0.99	0.18
5	5	370	16.5	535	89.4	0.96	0.12
6	1	395	-	650	-	0.94	-
7	0	-	-	-	-	-	-
8	1	287	-	555	-	1.04	-

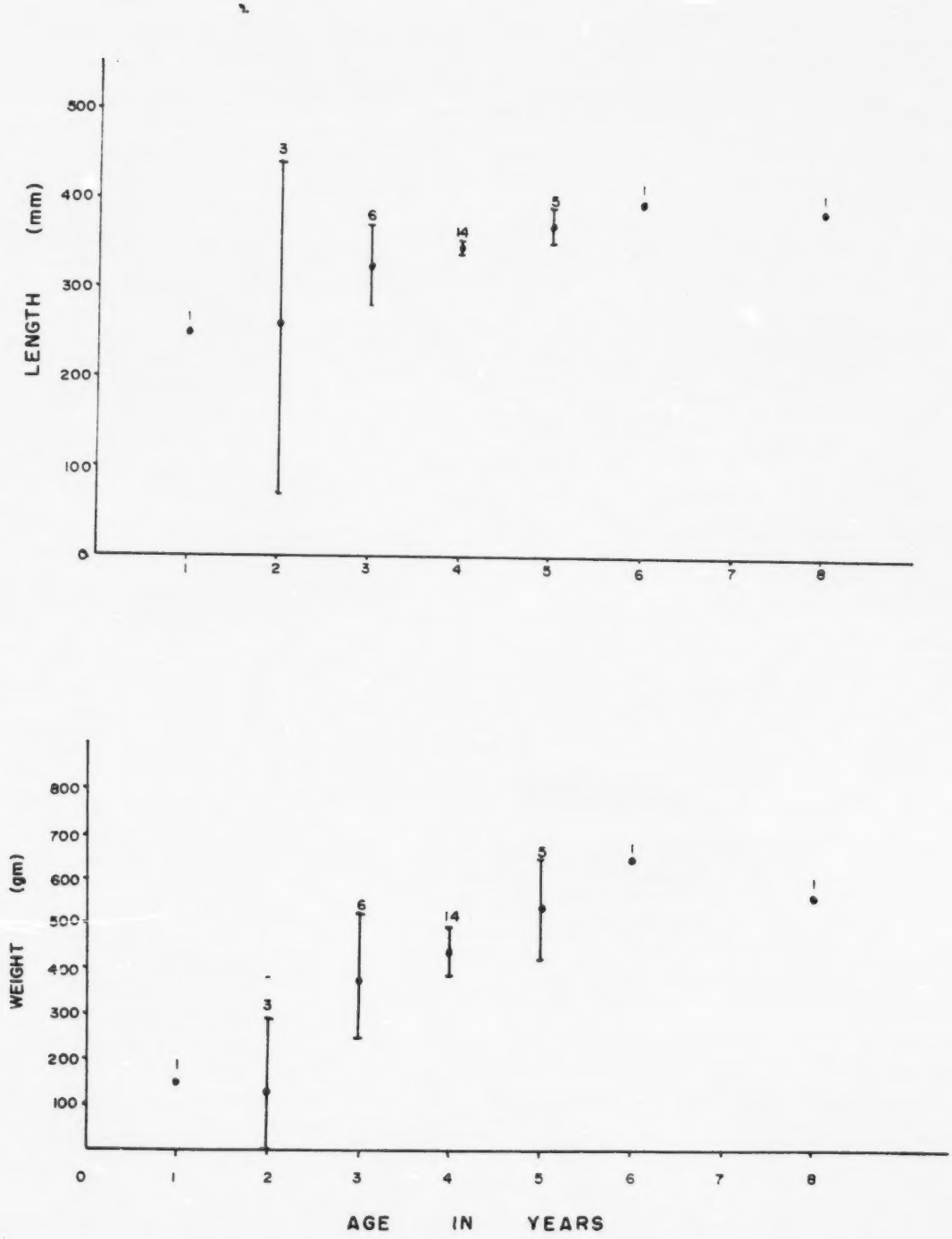

Fig. 13. Relationship between age and length (upper) and age and weight (lower) of Arctic grayling from Fox Lake, 1983 (± 95% confidence limits and sample sizes are indicated).

1.10 in Marsh Lake were lower than those derived in other Yukon lakes and from studies conducted in the Northwest Territories (Falk and Gillman 1980). The low value for Fox Lake grayling seems to indicate a reduced state of "fatness" at the expense of the accelerated growth rate.

Sex composition and maturity

The sex ratios of the lake trout catch in Fox, Marsh and Tagish lakes are summarized in Table 14. Females comprised 64% to 66% of the trout catches in Fox and Marsh lakes, and 53% in Tagish Lake. Reasons for the disproportionate representation of females in catches from all lakes are unknown. Further investigations related to species behaviour would be required before any conclusion can be drawn.

Trends in maturation of lake trout from Fox and Tagish lakes are evident in Table 15. Immature trout were found up to the age of nine years in Fox Lake and 13 years in Tagish Lake. Maturing trout were found by age six in Fox Lake and by age eight in Tagish Lake. Since northern lake trout populations are believed not to spawn every year (Horler et al.1983), some confusion may arise when attempting to distinguish between truly maturing fish and those that are mature but not ready to spawn in the current year. Indications are that lake trout in the Yukon reach maturity by age 11 (Horler et al.1983). Keeping in mind the late maturing individuals, it is reasonable to assume that most fish over 11 years of age that were recognized as "maturing" were in fact mature fish which would not spawn that year.

Among the trout that were mature and ready to spawn, the youngest fish were seven years old in both Fox and Tagish lakes. Fifty percent of the trout population were found to be mature by seven years in Fox Lake and by 10 to 13 years in Tagish Lake (Table 15). The latter range is closer to the general trend determined for the Yukon Territory. It is interesting to note that although the trout from Tagish Lake are faster growing (see previous section), they do not mature until they are older and larger than the trout from Fox Lake.

CONCLUSIONS AND RECOMMENDATIONS

1. It was only possible to get total catch estimates for Fox Lake. Catch data indicated that the 1983 catches for lake trout, Arctic grayling and northern pike were well below the guideline harvests as reported in Horler et al.(1983). This was undoubtedly related to the poor weather conditions which prevailed in 1983. Efforts should continue to qualify the MEI estimation and its applicability to Yukon Lakes.

2. Although the harvest of grayling in Fox Lake in 1983 was well below the guideline harvest, concern was expressed for this species since the vast majority of angled grayling from Fox Lake were below the age of maturity. Grayling catch from Marsh Lake had even smaller fish compared to Fox Lake.

Table 14. Sex ratio of the lake trout catch in Fox, Marsh and Tagish lakes, 1983 (N gives sample size).

LAKE	Males N	Males (%)	Females N	Females (%)	Ratio M:F	Undetermined
Fox	17	(34)	39	(66)	0.44:1	3
Marsh	13	(36)	23	(64)	0.56:1	0
Tagish	83	(46)	99	(54)	0.84:1	14

Table 15. Trends in maturation of lake trout from Fox and Tagish lakes, 1983 (N gives sample size).

Fox Lake					Tagish Lake				
Age	N	% Immature	% Maturing	% Mature	Age	N	% Immature	% Maturing	% Mature
6	2	-	100.0	-	7	1	-	-	100.0
7	6	17.0	33.0	50.0	8	9	11.2	44.4	44.4
8	5	20.0	20.0	60.0	9	19	10.5	42.1	47.4
9	13	15.4	7.7	76.9	10	19	5.2	42.1	52.7
10	14	-	7.7	92.3	11	19	26.3	31.6	42.1
11	3	-	-	100.0	12	11	9.1	18.2	72.7
12	1	-	-	100.0	13	22	4.5	45.5	50.5
13	0	-	-	-	14	14	-	35.7	64.3
14	1	-	-	100.0	15	13	-	7.7	92.3
15	0	-	-	-	16	11	-	18.2	81.8
16	1	-	-	100.0	17	3	-	33.3	66.7
17	1	-	-	100.0	18	3	-	33.3	66.7
Total	47	8.5	14.9	76.6	19	5	-	20.0	80.0
					20	1	-	-	100.0
					21	2	-	50.0	50.0
					22	0	-	-	-
					23	2	-	50.0	50.0
					24	0	-	-	-
					25	0	-	-	-
					26	1	-	100.0	-
					27	0	-	-	-
					28	0	-	-	-
					29	1	-	-	100.0
					39	1	-	-	100.0
					Total	157	7.0	33.1	59.9

3. Most of the captured lake trout appeared to be retained whereas higher proportions of Arctic grayling and northern pike were released.

4. The C.P.U.E. values appeared to be lowest in most cases for lake trout indicating that for the lakes studied, catch rates of less than 0.2 lake trout per hour were common among the average anglers for the period July through August. Much higher catch rates could be expected when fishing for northern pike and Arctic grayling during this period.

5. An inverse relationship was suggested between the Morphoedathic Index and lake trout growth.

6. Age at maturity for lake trout varied between seven and 13 years.

7. Yukon residents comprised the largest portion of the sport fishing fraternity outnumbering tourists two to one.

8. Success of a creel census in determining total fish catch was inversely proportional to lake size and number of access points. It is therefore recommended that for lakes with size equal to or greater than Marsh Lake (10,000 ha), a creel census be used in subsampling fishermen to derive only information on C.P.U.E. and biological data. Total catches would have to be extrapolated from associated questionnaire data or aerial boat counts. However, more work is required to test the techniques for studying large lakes more thoroughly; for example using annual questionnaires, aerial boat counts and catch log books for fly-in operators. Combinations of techniques should also be explored; for example, creel census combined with questionnaires or with aerial surveys.

SUMMARY

During the summer of 1983, three road-access lakes all within 110 km of Whitehorse, Yukon Territory, were selected for a creel census. These included Fox (1,700 ha), Marsh (9,600 ha) and Tagish (35,400 ha) lakes. The objectives of this study were: to sample angler catch for species, size, age and sex; and, where possible, compare actual harvests with guideline yields previously calculated from the Morphoedaphic Index.

Utilizing interview techniques, catch and effort statistics were compiled from 1,103 active anglers who caught and retained a total of 981 fish (1,528 kg) representing a minimum 3,004 man-hours of effort. A portion of this catch was sampled for age, size and sex data.

At Fox Lake, 786 anglers harvested 171 fish of which 58% were lake trout Salvelinus namaycush, 30% Arctic grayling Thymallus arcticus, 5% northern pike Esox lucius, 5% humpback whitefish Coregonus clupeaformis, and 2% burbot Lota lota. Catch composition by weight which totalled 129.3 kg was 62% lake trout, 18% Arctic grayling, 8% northern pike, 9% humpback whitefish and 3% burbot. Thirty-one percent of the Fox Lake anglers were successful in catching at least one fish with hourly catch rates ranging from 0.13 lake trout to 0.74 Arctic grayling. Virtually all lake trout and burbot caught were retained,

whereas the incidence of catch and release of the other species was 32% for pike and 33% for grayling.

Relatively small size, limited number of access points, and concentrated cottage distribution combined with intensive monitoring from ice-out to mid-September contributed towards a relatively accurate account of fishing activity on Fox Lake. The estimated harvest of lake trout during the survey period appeared significantly below the annual guideline harvest for this species as determined from the MEI. However, inclement weather dampened fishing effort in all of the southern Yukon during 1983, likely contributing to lower than normal total catches. The majority of grayling captured in Fox Lake were below the mean age of maturity giving rise to concern for possible overexploitation.

The recorded catch from Marsh and Tagish lakes represented an undetermined portion of the total harvest from these lakes. Due to the large size of the lakes, broadly dispersed cottage population and widely distributed access points, complete harvest coverage was not possible. At Marsh Lake, 62 anglers reported a retained catch of 320 fish weighing a total of 431.5 kg. This catch consisted of: 61% lake trout by number and 79% by weight; 26% Arctic grayling by number and 8% by weight; and 13% northern pike by number and 13% by weight. Angler success was comparatively high with 55% catching at least one fish with hourly catch rates varying from 0.14 lake trout to 1.9 Arctic grayling.

The 255 anglers surveyed from Tagish Lake reported a success rate of 34% with hourly catches ranging from 0.14 lake trout to 1.24 northern pike. Here, the retained harvest amounted to 490 fish or 967 kg with lake trout comprising 94% of the catch by number and 94% by weight. Northern pike (5% by number and 6% by weight) and Arctic grayling (1% by number and less than 1% by weight) made up the remainder. Tagish Lake produced the largest trout with a mean weight of 1.8 kg compared to 1.6 kg average for Marsh and 0.7 kg for Fox Lake. The incidence of catch and release in both Marsh and Tagish Lakes was very limited.

In all lakes, the majority of anglers were Yukon residents followed by U.S. and non-Yukon Canadian residents.

Based on this study, the following recommendations were made: continue to monitor fish harvest while trying a variety of techniques including a combination approach such as questionnaires, and aerial and boat surveys; continue to develop estimates of fish yields for specific lakes placing emphasis on methodology; and conduct additional research into the size of the Artic grayling caught in the Fox and Marsh lake fisheries in response to concerns over potential overharvesting.

ACKNOWLEDGEMENTS

The authors wish to thank the field crew provided by the Federal Summer Canada Student Program sponsored by the Yukon Conservation Society, and

the Yukon Territorial Government Community Recovery Job Creation Program. The field crew included Elaine Baer, Karen Fedoriak, Gail Johnston, Ian Matthews, Shaun McFarland, Rudi Meister, Monique Minard, Debra Pardy, Karen Remillard and Sue Thompson. Thanks are also extended to Ed Ramsey for providing equipment and repairs and to Peter Etherton for logistical support, program planning and implementation, and consultation during the study. Robin Harrison and Gordon Ennis provided administrative support; Peter Etherton and Robin Harrison critically reviewed the manuscript ; Judy Robertson typed the final drafts and Alice Fedorenko edited and prepared the manuscript for publication.

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Appendix 1. Summary of Yukon sport fishing licence sales, 1960-1982.

YEAR	RESIDENT	NON-RES FULL TERM	NON-RES SHORT TERM	NON-RES TOTAL	TOTAL LICENCE SALES
60-61	2612	3721	-		6333
61-62	2600	3960	-		6560
62-63	2672	3687	-		6359
63-64	2857	4229	-		7080
64-65	2505	4185	-		6690
65-66	2543	5109	-		7652
66-67	2760	5916	-		8676
67-68	2679	6969	-		9648
68-69	2840	7483	-		10,323
69-70	2978	7513	-		10,491
70-71	4466	1386	2652	4038	8504
71-72	5585	711	3853	4564	10,149
72-73	5104	785	3719	4504	9608
73-74	6629	1039	4232	5271	11,900
74-75	7783	835	3245	4080	11,863
75-76	8578	1088	3549	4637	13,215
76-77	8836	869	3220	4089	12,925
77-78	9642	1105	3865	4970	14,612
78-79	10,401	1351	3969	5320	15,721
79-80	10,98/	2343	3503	5846	16,835
80-81	11,892	1911	3460	5371	17,263
81-82	11,867	1910	3574	5484	17,351
82-83	9898	1384	2380	3764	13,662

Appendix 2. Creel census recording form, Department of Fisheries and Oceans, 1983.

Date: _____

Water Body: _____

Location: _____

Legend

LT = Lake Trout
G = Grayling
P = Pike
BB = Burbot

HW = Humpback Whitefish
RW = Round Whitefish
BW = Broad Whitefish
LC = Least Cisco

SC = Spin Cast
FL = Fly Rod

BH = Baited Hook
DR = Downrigger

Time	# in party	Ang. Res.	Species	Gear	# Caught	# Kept	Est. Wt. Kept	# of Ang. Hours	Species Preferred	Interview Frequency	Fish Sampled	COMMENTS